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Water Monitoring Management

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SANITARY SURVEY

LITTLE EGG HARBOR TO BARNEGAT BAY

1995 - 1999

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SANITARY SURVEY

LITTLE EGG HARBOR TO BARNEGAT BAY

1995-1999

New Jersey Department of Environmental Protection
ROBERT C. SHINN, Jr.
COMMISSIONER

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

EXECUTIVE SUMMARY

The results of water quality analysis of samples collected between January 1995 and December 1999 indicate that the *Approved* waters in the shellfish growing area consisting of the bay waters extending from Barnegat Inlet to northern Little Egg Harbor met all criteria for classification as *Approved*. All waters classified as other than *Approved* also met criteria for their respective classifications. There is one major source of impacts in this area, the Oyster Creek Nuclear Generating Facility, for which there were no indications of impacts to *Approved* waters of this area. An area of 191 acres along the northwestern shoreline of this area is recommended for upgrade from *Special Restricted* classification to *Seasonally Approved* classification. This area is sampled under systematic random sampling strategy and there are no changes recommended for the sampling schedule.

INTRODUCTION

PURPOSE

This report is part of a series of studies having a dual purpose. The first and primary purpose is to comply with the guidelines of the National Shellfish Sanitation Program (NSSP) that are established by the Interstate Shellfish Sanitation Conference (ISSC). Reports generated under this program form the basis for classifying shellfish waters for the purpose of harvesting shellfish for human consumption. As such, they provide a critical link in protecting human health.

The second purpose is to provide input to the State Water Quality Inventory Report, which is prepared pursuant to Section 305(b) of the Federal Clean Water Act (P.L. 95-217). The information contained in the growing area reports is used for the New Jersey State Water Quality Inventory Report (305b) which provides an assessment to Congress every two years of current water quality conditions in the State's major rivers, lakes, estuaries, and ocean waters. The reports provide valuable information for the 305(b) report, which describes the waters that are attaining state designated water uses and national clean water goals; the pollution problems identified in surface waters; and the actual or potential sources of pollution. Similarly, the reports utilize relevant information contained in the 305(b) report, since the latter assessments are based on instream monitoring data (temperature, oxygen, pH, total and fecal coliform bacteria, nutrients, solids, ammonia and metals), land-use profiles, drainage basin characteristics and other pollution source information.

From the perspective of the Shellfish Classification Program, the reciprocal use of water quality information from reports represent two sides of the same coin: the growing area report focuses on the estuary itself, while the 305(b) report describes the watershed that drains to that estuary.

The Department participates in a cooperative National Environmental Performance Partnership System (NEPPS) with the USEPA which emphasizes ongoing evaluation of issues associated with environmental regulation, including assessing impacts on waterbodies and measuring improvements in various indicators of environmental health. The shellfish growing area reports are intended to provide a brief assessment of the growing area, with particular emphasis on those factors that affect the quantity and quality of the shellfish resource. As the Department implements a comprehensive watershed management program in conjunction with the NEPPS initiative, the shellfish growing area reports provide valuable information on the overall quality of the saline waters in the most downstream sections of each major watershed. In addition, the reports assess the quality of the biological resource and provide a reliable indicator of potential areas of concern and/or areas where additional information is needed to accurately assess watershed dynamics.

HISTORY

As a brief history, the NSSP developed from public health principles and program controls formulated at the original conference on shellfish sanitation called by the Surgeon General of the United States Public Health Service in 1925. This conference was called after oysters were implicated in causing over 1500 cases of typhoid fever and 150 deaths in 1924. The tripartite cooperative program (federal, state and shellfish industry) has updated the program procedures and guidelines through workshops held periodically until 1977. Because of concern by many states that the NSSP guidelines were not being enforced uniformly, a delegation of state shellfish officials from 22 states met in 1982 in Annapolis, Maryland, and formed the ISSC. The first annual meeting was held in 1983 and continues to meet annually at various locations throughout the United States.

The NSSP *Guide for the Control of Molluscan Shellfish* sets forth the principles and requirements for the sanitary control of shellfish produced and shipped in interstate commerce in the United States. It provides the basis used by the Federal Food and Drug Administration (FDA) in evaluating state shellfish sanitation programs. The five major points on which the state is evaluated by the FDA include:

1. The classification of all actual and potential shellfish growing areas as to their suitability for shellfish harvesting.
2. The control of the harvesting of shellfish from areas that are classified as restricted, prohibited or otherwise closed.
3. The regulation and supervision of shellfish resource recovery programs.
4. The ability to restrict the harvest of shellfish from areas in a public health emergency, and
5. Prevent the sale, shipment or possession of shellfish that cannot be identified as being produced in accordance with the NSSP and have the ability to condemn, seize or embargo such shellfish.

FUNCTIONAL AUTHORITY

The authority to carry out these functions is divided between the Department of Environmental Protection (DEP), the Department of Health and Senior Services and the Department of Law and Public Safety. The Bureau of Marine Water Monitoring (BMWM) under the authority of N.J.S.A. 58:24 classifies the shellfish growing waters and administers the special resource recovery programs. Regulations delineating the growing areas are promulgated at N.J.A.C. 7:12 and are revised annually. Special Permit rules are also found at N.J.A.C. 7:12 and are revised as necessary.

The Bureau of Shellfisheries in the Division of Fish, Game and Wildlife issues harvesting licenses and leases for shellfish grounds under the Authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This bureau in conjunction with the BMWM administers the Hard Clam Relay Program.

The Bureau of Law Enforcement in the DEP (Division of Fish, Game, and Wildlife) and the Division of State Police in the Department of Law and Public Safety enforce the provisions of the statutes and rules mentioned above.

The Department of Health and Senior Services is responsible for the certification of wholesale shellfish establishments and in conjunction with the BMWM, administers the depuration program.

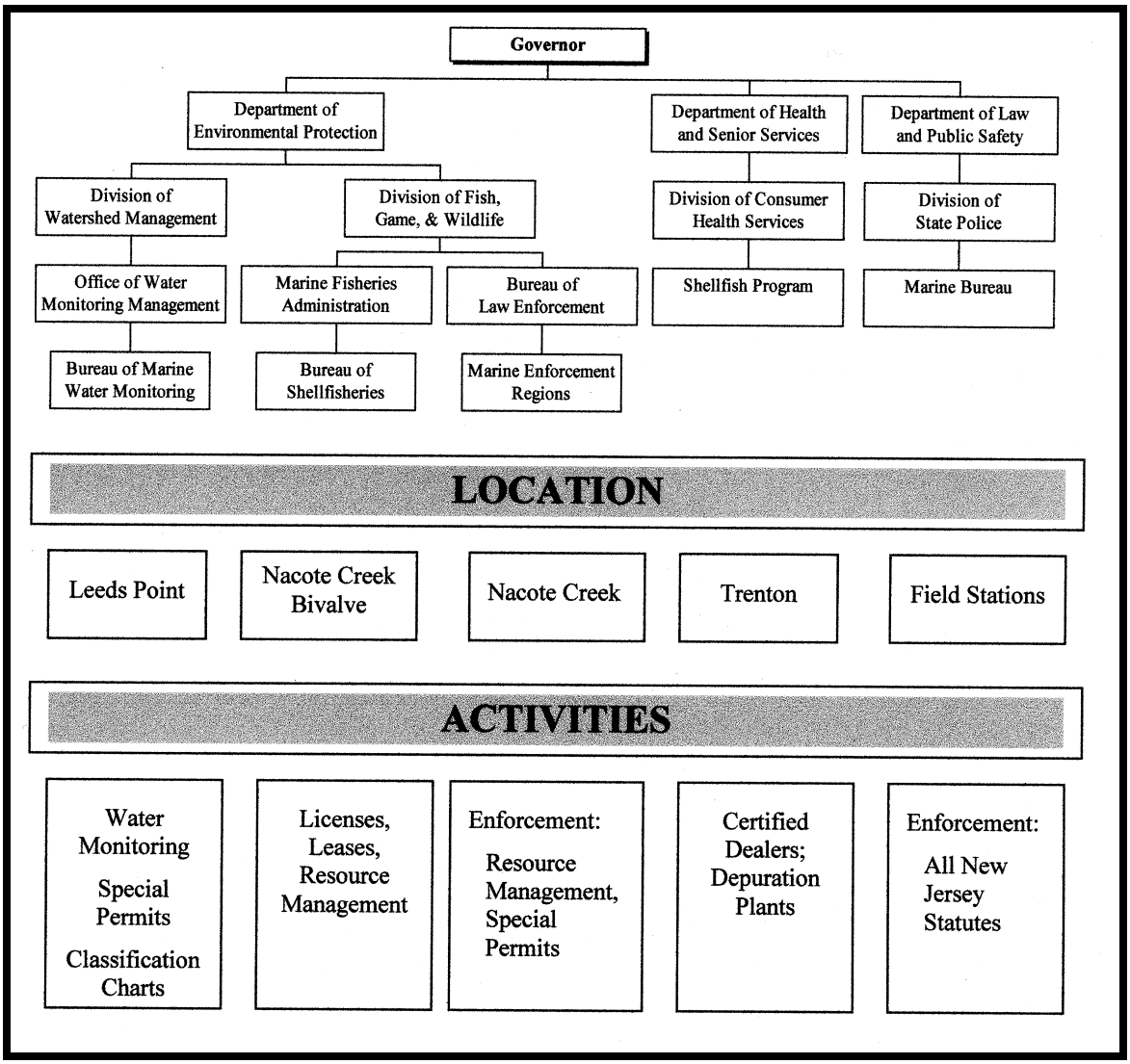


FIGURE 1: STATE OF NEW JERSEY SHELLFISH AGENCIES

IMPORTANCE OF SANITARY CONTROL OF SHELLFISH

Emphasis is placed on the sanitary control of shellfish because of the direct relationship between pollution of shellfish growing areas and the transmission of diseases to humans. Shellfish borne infectious diseases are generally transmitted via a fecal-oral route. The pathway is complex and quite circuitous. The cycle usually begins with fecal contamination of the shellfish growing waters. Sources of such contamination are many and varied. Contamination reaches the waterways via runoff and direct discharges.

Clams, oysters and mussels pump large quantities of water through their bodies

during the normal feeding process. During this process the shellfish also concentrate microorganisms, which may include pathogenic microbes, and toxic heavy metals/chemicals. It is imperative that a system is in place to reduce the human health risk of consuming shellfish from areas of contamination.

Accurate classifications of shellfish growing areas are completed through a comprehensive sanitary survey. The principal components of the sanitary survey report include:

1. An evaluation of all actual and potential sources of pollution,
2. An evaluation of the hydrography of the area and
3. An assessment of water quality. Complete intensive sanitary surveys are conducted every 12 years with interim narrative evaluations completed on a three year basis. If major changes to the shoreline or bacterial quality occur, then the intensive report is initiated prior to its l2 year schedule.

The following narrative constitutes this Bureau's assessment of the above mentioned components and determines the current classification of the shellfish growing waters.

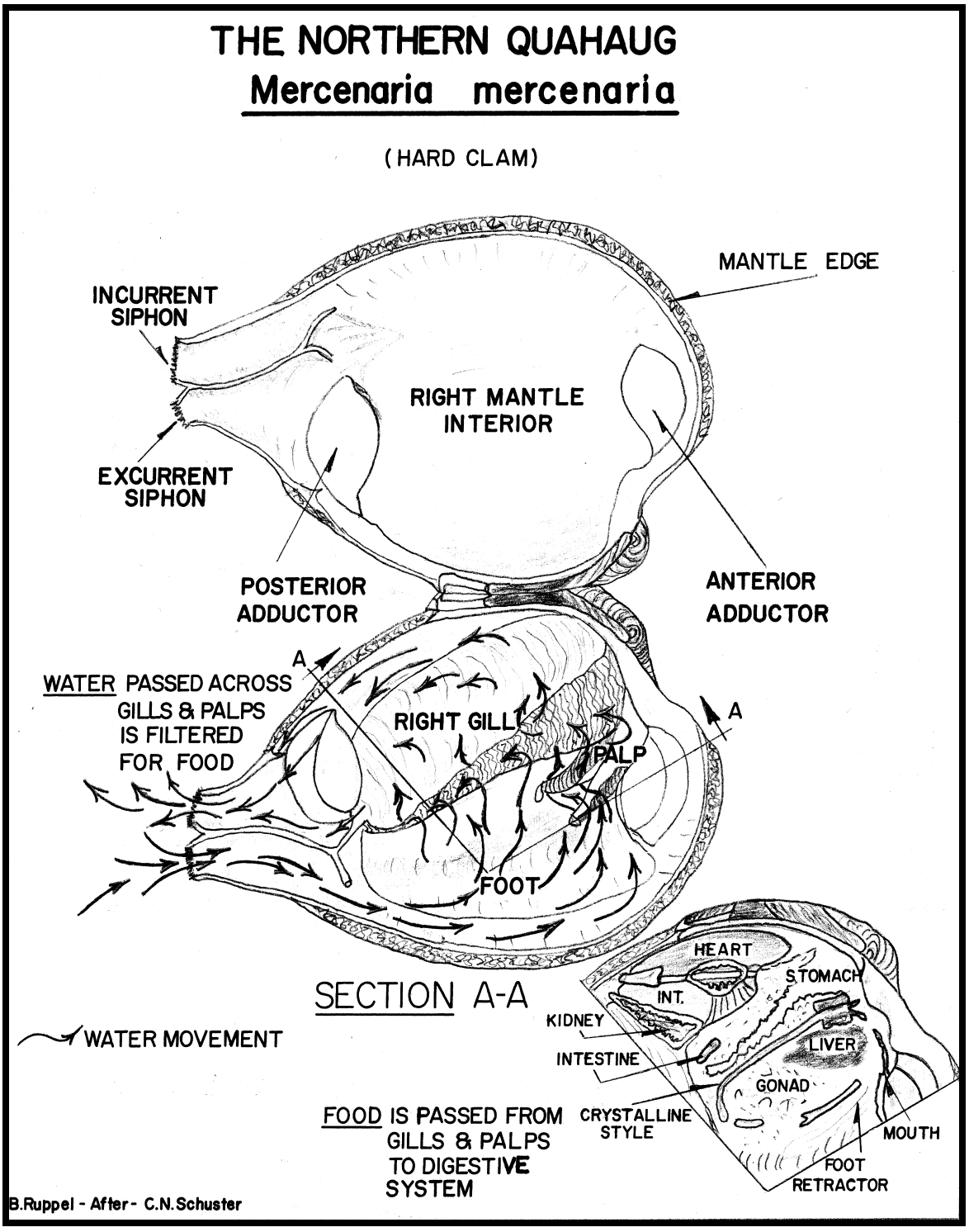


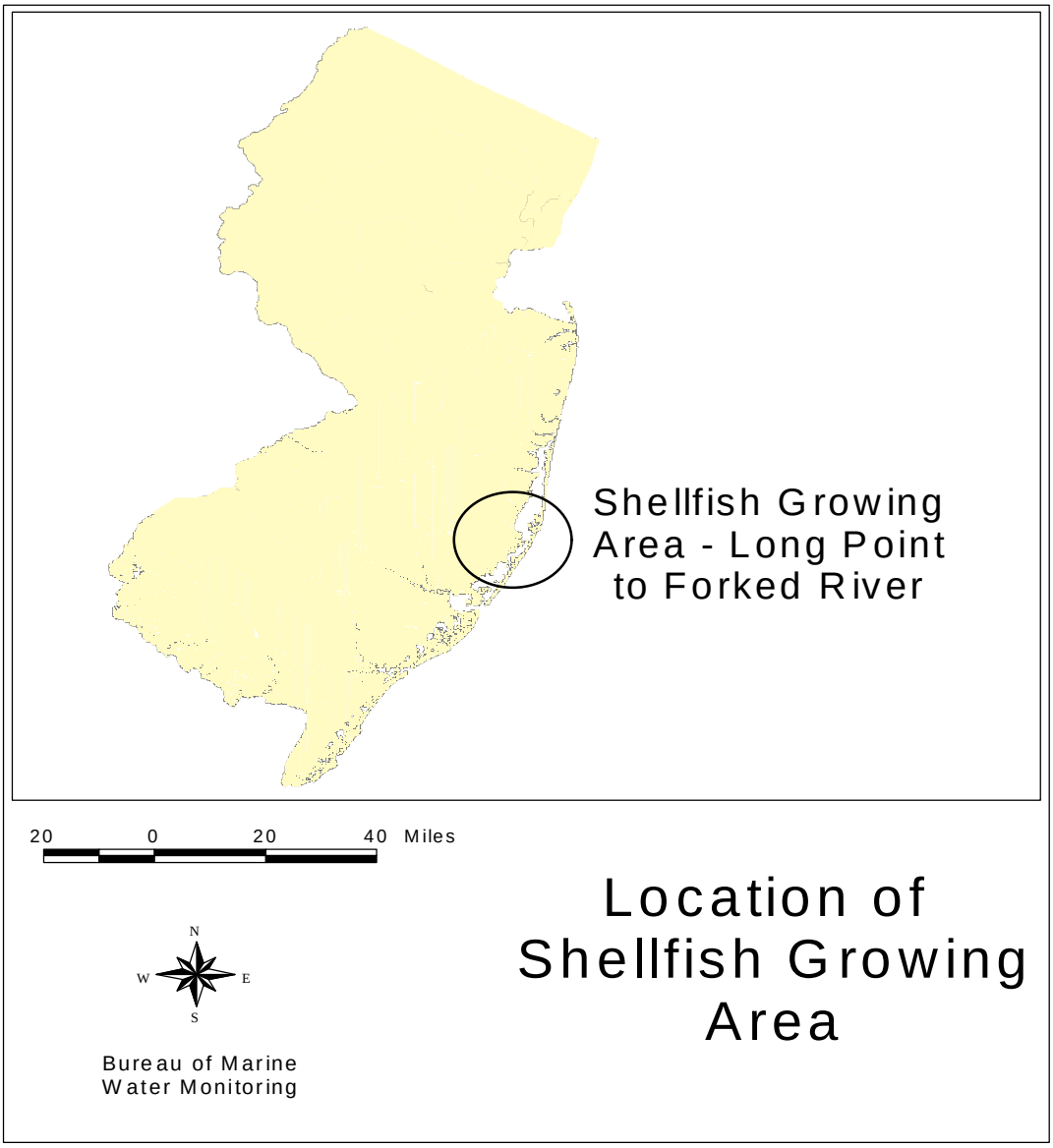
FIGURE 2: CROSS-SECTION OF MERCENARIA MERCENARIA

DESCRIPTION

LOCATION

This Sanitary Survey covers the shellfish growing waters of southern Barnegat Bay and northern Little Egg Harbor Bay. The area covered extends approximately seventeen (17) miles from Forked River across the bay to Long Beach State Park, on the north to Spray Beach on the south. This area is also displayed on charts #4, #5 and #6 of the current Shellfish Growing Water Classification Charts. The last Sanitary Survey for this area was completed in 1988. The last Reappraisal of this area was completed in 1996.

FIGURE 3: LOCATION OF SHELLFISH GROWING AREA

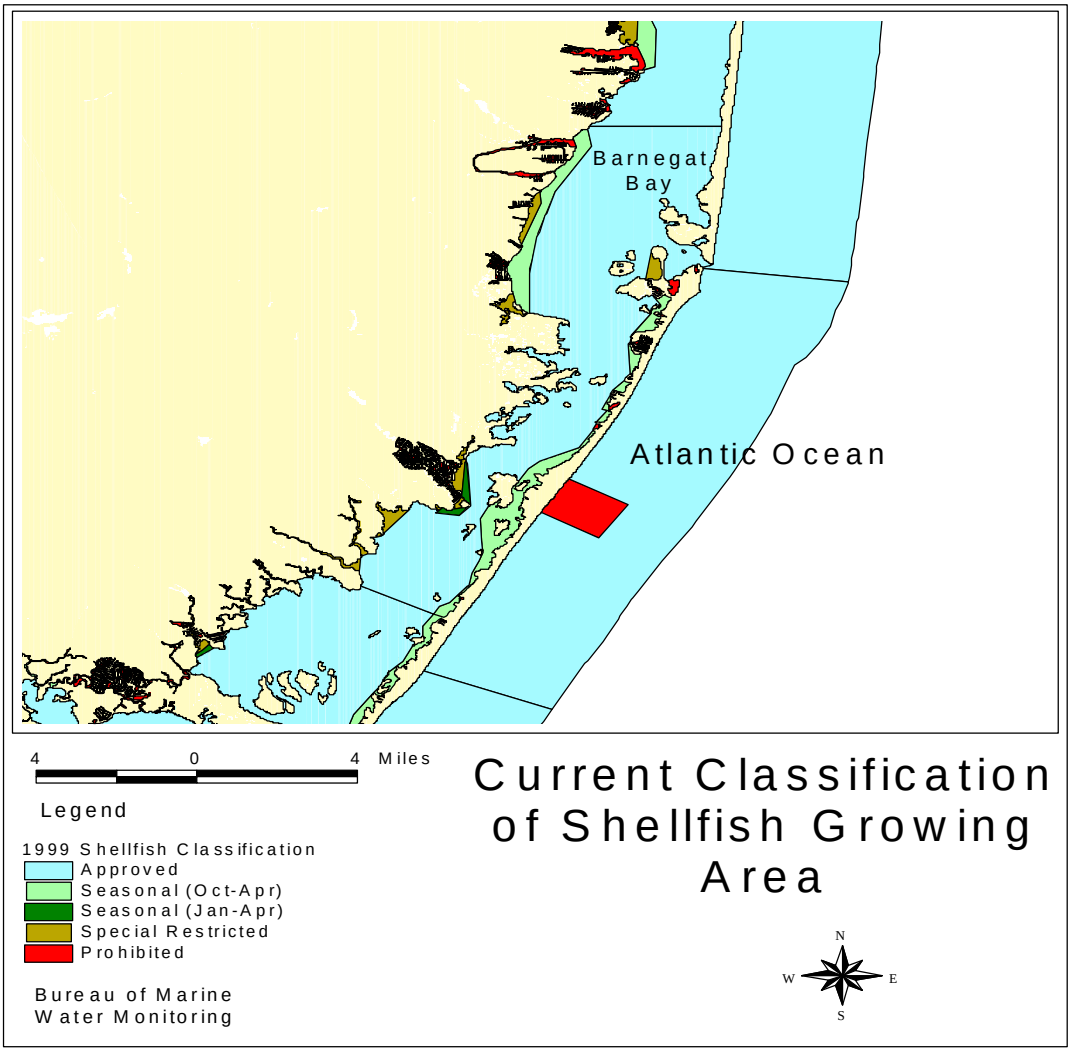


DESCRIPTION

The majority of the shellfish waters present in this area are classified as *Approved*, with several small sections of *Seasonally Approved*, *Special Restricted* and *Prohibited* waters which act as buffers along the developed sections of the shoreline along the bay. *Approved* and *Seasonally Approved* sections of this area are available for the harvest of hard clams (*Mercenaria mercenaria*) and soft shelled clams (*Mya arenaria*). Shellfish harvested from *Special Restricted* waters must undergo either depuration or relay. The *Special Restricted* waters in this area have not been harvested for several years due to lack of interest by fishermen.

The discharge from the Oyster Creek Nuclear Generating Station is located within this area. This facility does not discharge sanitary waste, instead discharging non-contact cooling water. The effluent from this facility does not impact the *Approved* waters bordering the closed safety zone surrounding the discharge pipe of the facility.

FIGURE 4: CURRENT CLASSIFICATION OF SHELLFISH GROWING AREA



HISTORY

The discharge from the Oyster Creek Nuclear Generating Station power plant, operated by the GPU Nuclear Corporation, has historically not significantly impacted the region's receiving waters with elevated total coliform levels (a pollution indicating organism). The discharge from this facility is located between Oyster Creek and Forked River. The effluent from this pipe is non-contact cooling water utilized in the operation of the power plant. This source is unlikely to directly impact levels of microorganisms. The elevated temperatures of the thermally polluted non-contact cooling water have the potential to promote growth of microorganisms, but there is no evidence that this has caused any problems impacting the *Approved* waters of this area.

Oyster Creek Nuclear Generating Station is required by its permit to operate as a nuclear generating station to monitor for radio nucleotides in the environment quarterly. The report is provided to the New Jersey Department of Environmental Protection, Bureau of Radiation Protection. No problems have been identified with the operation of the plant which could impact the quality of shellfish from the *Approved* shellfish growing waters. A closed safety zone is still required to surround the discharge pipe from this facility.

A history of "brown tide" algal blooms exists for this area. In 1988, the first brown tide was identified in lower Barnegat Bay. In 1995, a brown tide was identified in Little Egg Harbor. In 1997, a brown tide was again identified in the lower Barnegat Bay, upper Little Egg Harbor Bay area. Also in 1998, a brown tide was identified in this area. Once again in 1999, a large brown tide was identified in this area.

There are no known threats to human health from brown tides. However, brown tides create unpleasant aesthetics to the water resources, which negatively impact recreational activities, such as swimming, fishing and boating. Additionally, brown tide algal blooms can reduce shellfish growth by a inhibitory substance on the cell surface which reduces feeding response in some molluscan shellfish, such as hard clams. Brown tides can also reduce habitat by reducing the light that reaches eel grass beds which provide nursery habitat. The food web is also disrupted by brown tide algal blooms, which can cause a reduction in finfish populations.

The last Sanitary Survey covering this area was performed in 1988. At which time, most of the currently standing classifications for shellfish growing water in this area were established. The last Reappraisal was performed in 1996. This report found that all bacteriological data supported the current classifications of the growing water and recommended no changes.

METHODS

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 1992).

Approximately 5500 water samples were collected for total and fecal coliform bacteria between 1995 and 1999 and analyzed by the three tube MPN method according to APHA (1970). Figure 25 shows the Shellfish Growing Water Quality monitoring stations in the bay waters from Little Egg Harbor to Barnegat Bay. Approximately 160 stations are monitored during each year.

Water quality sampling, shoreline and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish,* 1997.

Data management and analysis was accomplished using database applications developed for the Bureau. Mapping of pollution data was performed with the Geographic Information System (GIS:ARCVIEW).

BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS

The water quality of each growing area must be evaluated before an area can be classified as *Approved, Seasonally Approved, Special Restricted,* or *Seasonal Special Restricted*. Criteria for bacterial acceptability of shellfish growing waters are provided in NSSP *Guide for the Control of Molluscan Shellfish,* 1997. Each shellfish producing state is directed to adopt either the total coliform criterion, or the fecal coliform criterion. While New Jersey bases its growing water classifications on the total coliform criterion, it does make corresponding fecal coliform determinations for each sampling station, these data are viewed as adjunct information and are not directly used for classification. The State Shellfish Control Authority also has the option of choosing one of two water monitoring sampling strategies for each growing area.

The Adverse Pollution Condition Strategy requires that a minimum of five samples be collected each year under conditions that have historically resulted in elevated coliforms in the particular growing area. The results must be evaluated by adding the individual station sample results to the preexisting bacteriological sampling results to constitute a data set of at least 15 samples for each station. The adverse pollution conditions usually are related to tide, and rainfall, but could be from a point source of pollution or variation could occur during a specific time of the year. Under this strategy, for *Approved* waters, the total coliform median or geometric mean MPN of the water shall not exceed 70 per 100 mL and not more than 10 percent of the samples exceed an MPN of 330 per 100 mL for the 3-tube decimal dilution test. For *Special Restricted* waters, the total coliform median or geometric mean MPN of the water shall not exceed 700 per 100 mL and not more than 10 percent of the samples exceed an MPN of 3300 per 100 mL for the 3-tube decimal dilution test. Areas to be Approved under the Seasonal classification must be sampled and meet the criterion during the

time of the year that it is approved for the harvest of shellfish.

The Systematic Random Sampling strategy requires that a random sampling plan be in place before field sampling begins and can only be used in areas that are not affected by point sources of contamination. A minimum of six samples per station are to be collected each year and added to database to obtain a sample size of 30 for statistical analysis. The bacteriological quality of every sampling station in *Approved* areas shall have a total coliform median or geometric mean MPN not exceeding 70 per 100 mL and the estimated 90th percentile shall not exceed an MPN of 330 per 100 mL. For *Special Restricted* areas, the bacteriological quality shall not exceed a total coliform median or geometric mean MPN of 700 per 100 mL and the estimated 90th percentile shall not exceed an MPN of 3,300 per 100 mL.

The bay waters from Little Egg Harbor to Barnegat Bay are sampled under the Systematic Random Sampling Strategy described above. The Systematic Random Sampling Strategy is utilized in this shellfish growing area because there are no wastewater treatment facility discharge pipes present in this area. Historically, this area has shown a tendency for impact from rainfall, particularly during the summer months. However, the rainfall impacts in this area do not impair water quality to an extent that *Approved* criteria are no longer achieved.

MARINE BIOTOXINS

The Department collects samples at regular intervals throughout the summer to determine the occurrence of marine biotoxins. This data is evaluated weekly by the Bureau of Marine Water Monitoring in accordance with the NSSP requirements. An annual report is compiled. This is discussed further on pages 53 and 58.

SHORELINE SURVEY

EVALUATION OF BIOLOGICAL RESOURCES

There are two (2) molluscan shellfish species which are of commercial importance in bay waters in New Jersey, the hard clam (*Mercenaria mercenaria*) and the soft clam (*Mya arenaria*). There are no quotas set on the harvest of shellfish in *Approved* and *Seasonally Approved* areas. Areas designated as *Seasonally Approved* can only be harvested during winter months. The winter months during which a *Seasonally Approved* area can be harvested is either November through April, or January through April, depending on the impacts in the area.

In areas designated as *Special Restricted* a depuration or relay program must be in place for harvesting to occur. Quotas are set on the amount of shellfish which can be brought for depuration or undergo relay. The quotas for depuration are set by the depuration plants in connection with the baymens associations local to

the area. The quotas for relay are set by the New Jersey Shellfish Council which oversees the relay program. The New Jersey Shellfish Council is comprised of nine (9) members appointed by the governor of New Jersey. The members are chosen based on having one member from each county where shellfishing is performed, with two members from Cape May County. The Shellfish Council is split into two sections, Atlantic Coast section and (Maurice River Cove) Delaware Bay section. One member from Cape May County serves on each section of the council. Member are chosen for the council based on being shellfishermen and having demonstrated knowledge of the issues involved in maintenance of shellfisheries.

There are occasional occurrences of algal blooms in all marine waters in New Jersey. Algal blooms tend to occur in marine waters in late summer months, during periods of hot weather. The primary adverse effect of the algal blooms on water quality is on the aesthetic quality. No occurrences of algal blooms connected with the presence of biotoxins have been recorded for the time period covered by this report. The Department collects samples at regular intervals throughout the summer to determine the occurrence of marine biotoxins. This data is evaluated weekly by the Bureau of Marine Water Monitoring in accordance with the NSSP requirements.

FIGURE 5: LOCATION OF CLAM RESOURCES IN UPPER BARNEGAT BAY REGION

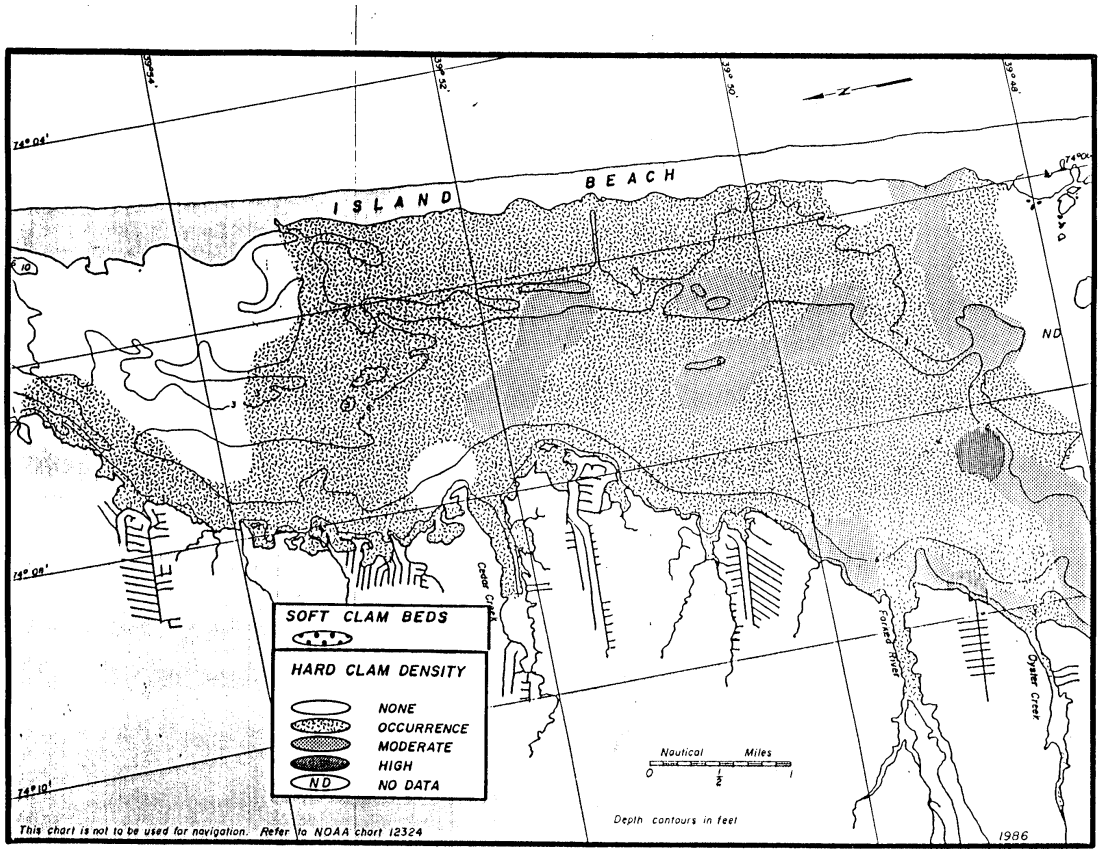
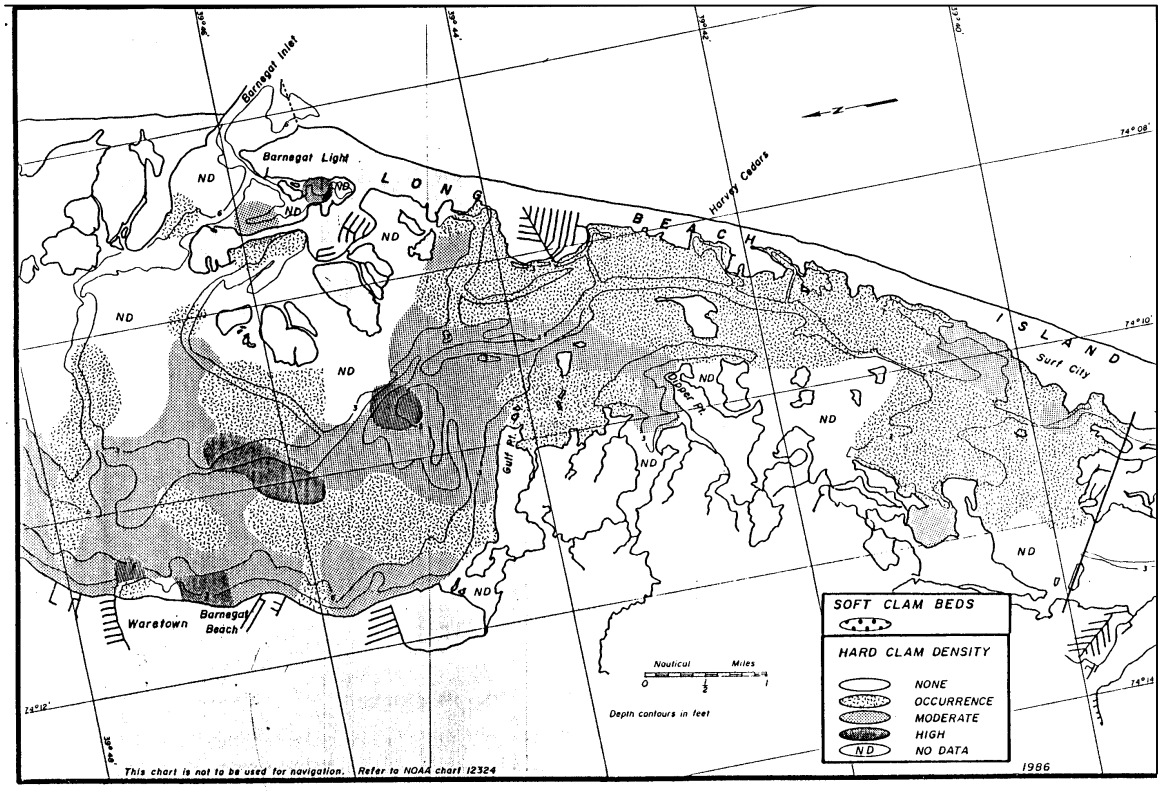


FIGURE 6: LOCATION OF CLAM RESOURCES IN MIDDLE BARNEGAT BAY REGION



LAND USE

There are several types of land use which are prevalent in this area. The majority of the land use in this area is wetlands, forests and urban development. There is very little agriculture in the area. Little impact can be expected from runoff bearing fecal waste from domesticated farm animals.

On the mainland side of the bay there are large areas of wetlands, which become forested lands heading back further inland. Most of the wetlands are on the protected lands of the Edwin Forsythe National Wildlife Refuge. Wetlands function to purify water through pollutants being used as nutrients for plant growth. The large amounts of wetlands in this area help to maintain water quality in this area. However, feral animal populations present in the wetlands can contribute significant impacts. Particularly significant impacts can come from flocks of wild birds, both indigenous and migratory, living in or migrating through the wetlands in this area. Fecal waste from the feral populations are deposited directly into the waters of this area and also carried by storm runoff.

The mainland side of the bay also has several urban developed areas. The majority of the urban developed areas on the mainland side of the bay consist of lagoon communities. Lagoon communities consist of lanes of dredged lagoons running through a developed residential community to provide access to the bay for residents of the

communities. Recreational boating activity during the summer can be a significant source of impact to these waters. Some boats will discharge sanitary waste into the waters of the bay. There are pump outs available for removing the sanitary waste from the boats at many marinas. However, not all boat owners dispose of their sanitary waste properly, and some of the sanitary waste from boats is discharged directly to bay waters. In addition, waste material from two cycle engines in the boats can impact the waters. Recreational boating can become a more significant impact in proximity to lagoon communities due to the presence of large number of residences with direct access to water.

Storm runoff from urban developed communities can contain fecal waste from domestic pets, petroleum waste from spilled or leaked material from automobiles and many other types of pollutants. Storm runoff from all of the urban developed areas can cause impacts to the waters of this area, but especially runoff entering the lagoons in the lagoon communities. The waters in the lagoons tend to stagnate with tidal exchange being the primary mode for movement of the water in the lagoons. As the water stagnates, it has potential to accumulate pollutants. The canals of the lagoon communities are all classified as *Prohibited*. Most of the lagoon communities have a buffer of either *Seasonally Approved* or *Special Restricted* waters.

Additionally, all the urban communities have storm drains which collect the storm runoff and convey it to outfalls. The storm drain outfalls release the collected storm water runoff into the bay and into rivers and streams which empty to the bay. The storm water released by the outfalls can have numerous pollutants. In addition, the first flush from storm drains can carry an even heavier impact due to pollutants deposited in the drains from being flushed out with storm surge.

The barrier islands on the eastern side of the bay also contribute impacts to the waters of this area. The barrier islands north of Barnegat Inlet are part of a state park and are maintained almost entirely as wetlands in the part which extends into this area. contribute the similar impacts as already discussed for wetlands. The land use on the barrier islands south of Barnegat Inlet is almost totally urban development. The urban development on the barrier island introduces similar impacts to the impacts of the urban development already discussed.

The urban areas along the shoreline experience fluctuations in populations. Many communities along the shoreline have greatly increased populations during the summer due to tourism. The increased population can cause increased impacts to the waters of the growing area during the summer months. Many of the communities affected by large summer population fluctuations have buffers of *Seasonally Approved* waters.

There are numerous communities bordering this area further inland, which have minimal impact on the waters of this area. Most of the sewage from these communities is carried to wastewater treatment facilities by sanitary sewers. A few of the inland communities utilize septic systems, but due to the distance, this is unlikely to impact the waters of this shellfish growing area.

Barnegat Inlet allows for interaction of the waters of this area with waters of the Atlantic Ocean. The ocean waters bordering this area consist of *Approved* waters and are unlikely to adversely impact the waters of this area. The tidal flow of waters with the Atlantic Ocean helps flush the waters of this area and prevent accumulation of pollutants.

There are numerous small rivers and streams which empty into the waters of this area, including Forked River, Oyster Creek, and the small streams in the Edwin Forsythe National Wildlife Refuge. The streams that have significant urban development surrounding them, such as Forked River and Oyster Creek, are classified as *Prohibited* and have buffer zones of *Special Restricted* and *Seasonally Approved* waters to prevent adverse impacts to the *Approved* waters of this area. The streams in the area of the Edwin Forsythe National Wildlife Refuge are classified as *Special Restricted*.

FIGURE 7: LAND USE PATTERNS FOR SHELLFISH GROWING AREA

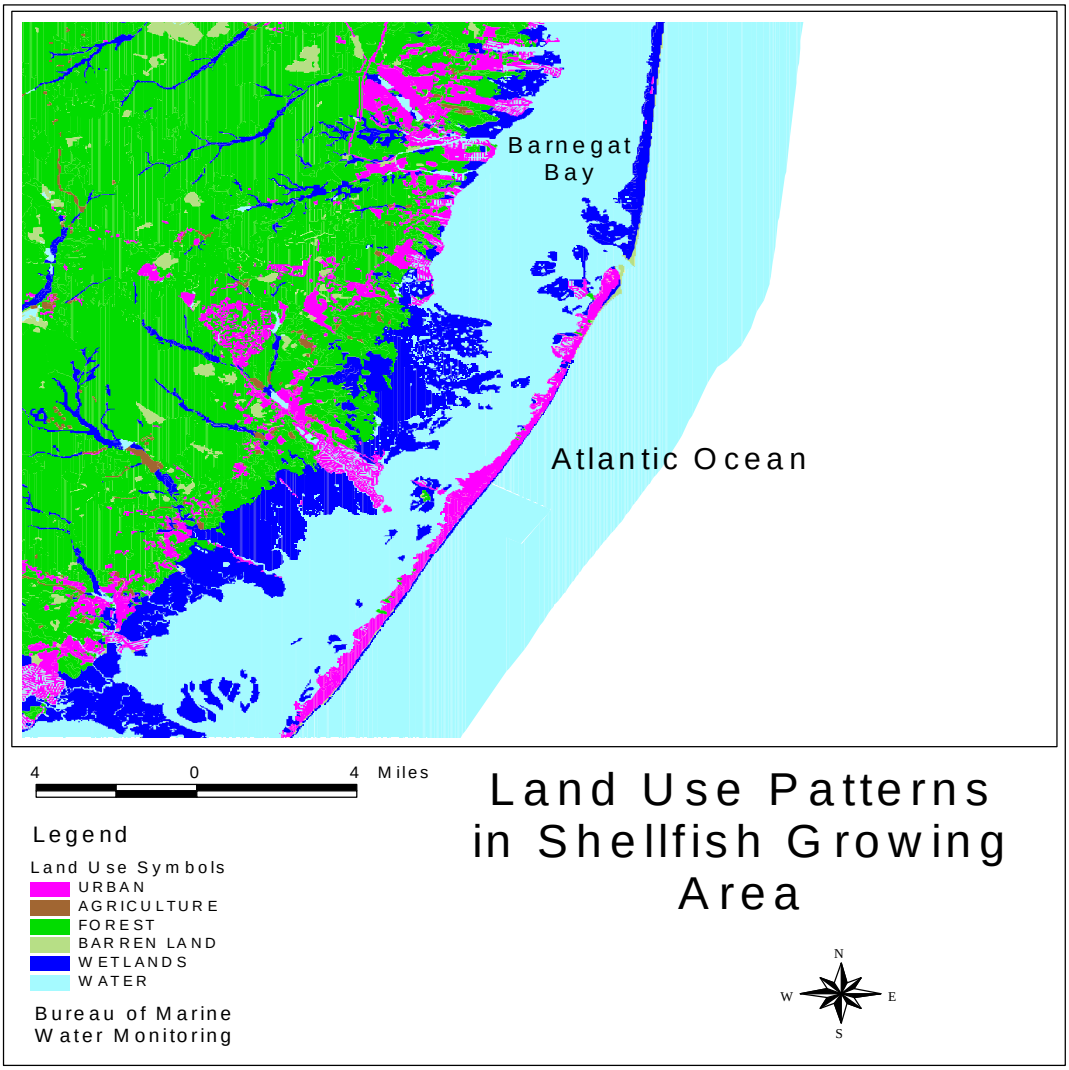


FIGURE 8: : MUNICIPALITIES IN PROXIMITY TO SHELLFISH GROWING AREA

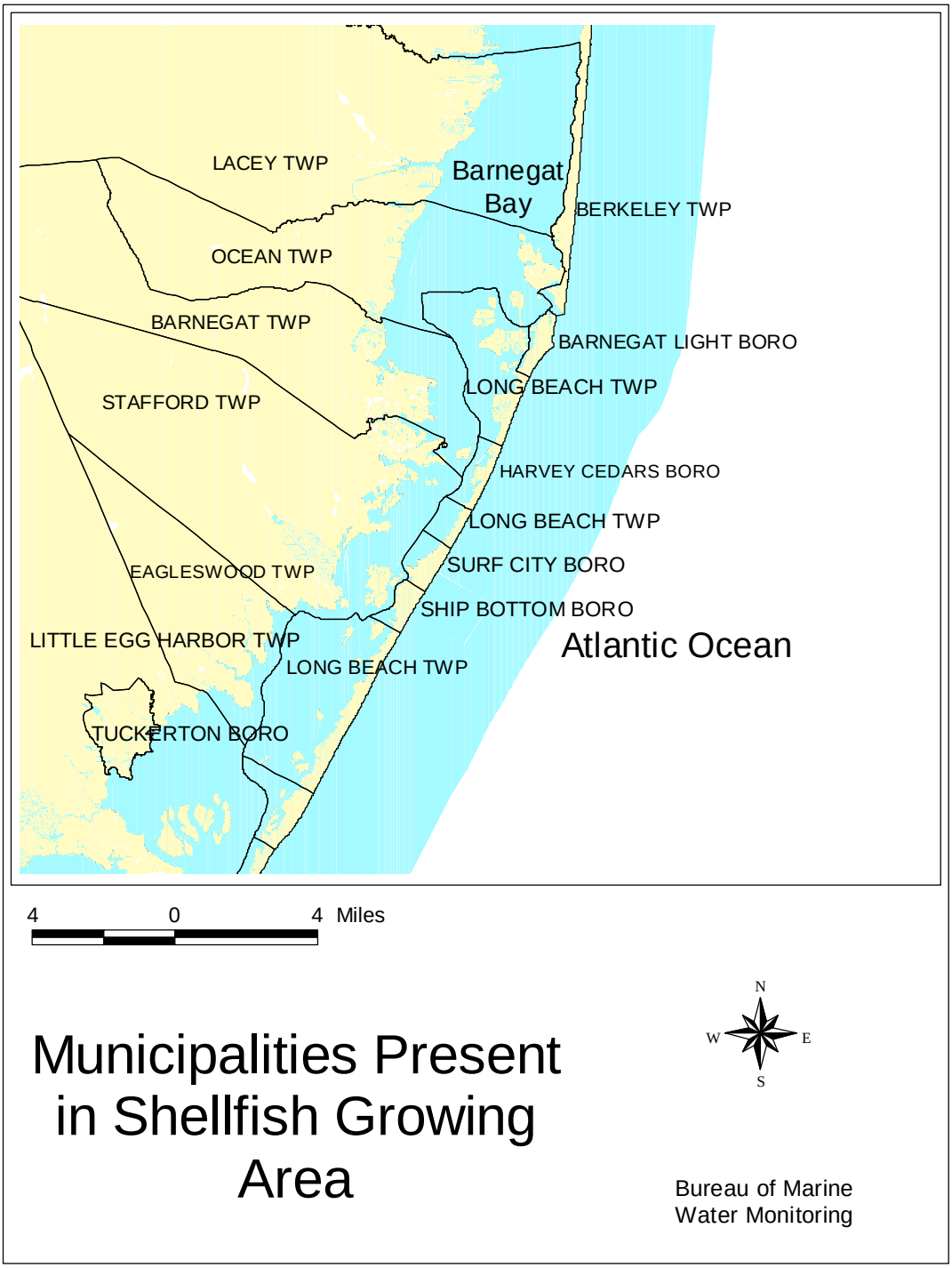


TABLE 1: POPULATION INFORMATION FOR SHELLFISH GROWING AREA

Community	Area (sq. mi.)	Population (1990 Census)	Population Density (population/sq.mi.)
Barnegat Township	39.9	12,235	307
Barnegat Light Boro	1.0	675	673
Berkeley Township	54.1	37,319	689
Eagleswood Township	18.9	1476	78
Harvey Cedars	1.4	362	267
Lacey Township	99.4	22,141	223
Little Egg Harbor	73.4	13,333	182
Long Beach Township	20.7	3232	156
Ocean Township	31.7	5416	171
Ship Bottom Boro	0.9	1352	1368
Stafford Township	55.1	13,325	242
Surf City Boro	1.3	1375	1042
Tuckerton Boro	3.7	3048	826

CHANGES SINCE LAST SURVEY

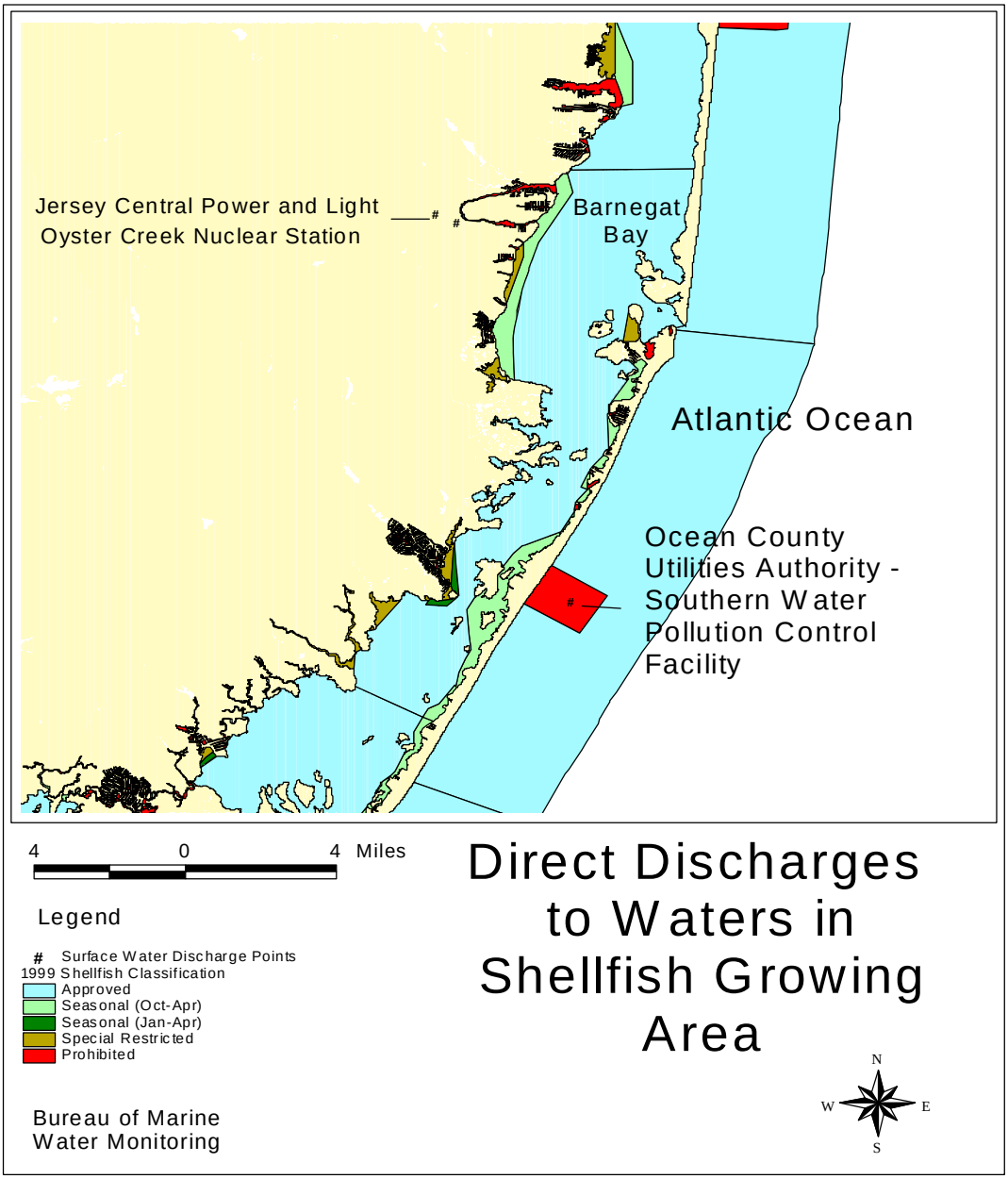
After Ocean County Utilities Authority – Southern Pollution Control Facility was built in proximity to this area, several residential developments were constructed. Subsequent to the increase in urban development in this area, sampling results indicated poor water quality along the northwestern shore of this area, from Forked River to Barnegat. The elevated coliform levels, which had been occurring in this area, appear to have decreased to levels similar to other sections of this area in recent years since construction of new developments has ceased. Current results indicate coliform levels which are consistent with the upgrade of the waters in this area to the *Seasonally Approved* classification. No markedly elevated coliform levels were experienced for specific dates in the winter.

IDENTIFICATION AND EVALUATION OF SOURCES

DIRECT SOURCES

There is only one direct source identified in this area, Oyster Creek Nuclear Generating Station. This facility discharges non-contact cooling water to Oyster Creek.

FIGURE 9: DIRECT DISCHARGES TO WATERS IN SHELLFISH GROWING AREA



Oyster Creek Nuclear Generating Station

On December 17, 1999, Steven Peters, Environmental Specialist, visited the Oyster Creek Nuclear Generating Station located on Route 9 in Forked River, New Jersey. Mr. Peters met with James Vouglitois, Manager of Environmental Affairs for Oyster Creek Nuclear Generating Station. This nuclear power plant is owned by GPU, Inc. and is operated by GPU Nuclear, Inc. a subsidiary company. This power plant utilizes a nuclear fission reaction to produce 650 MegaWatts of electricity.

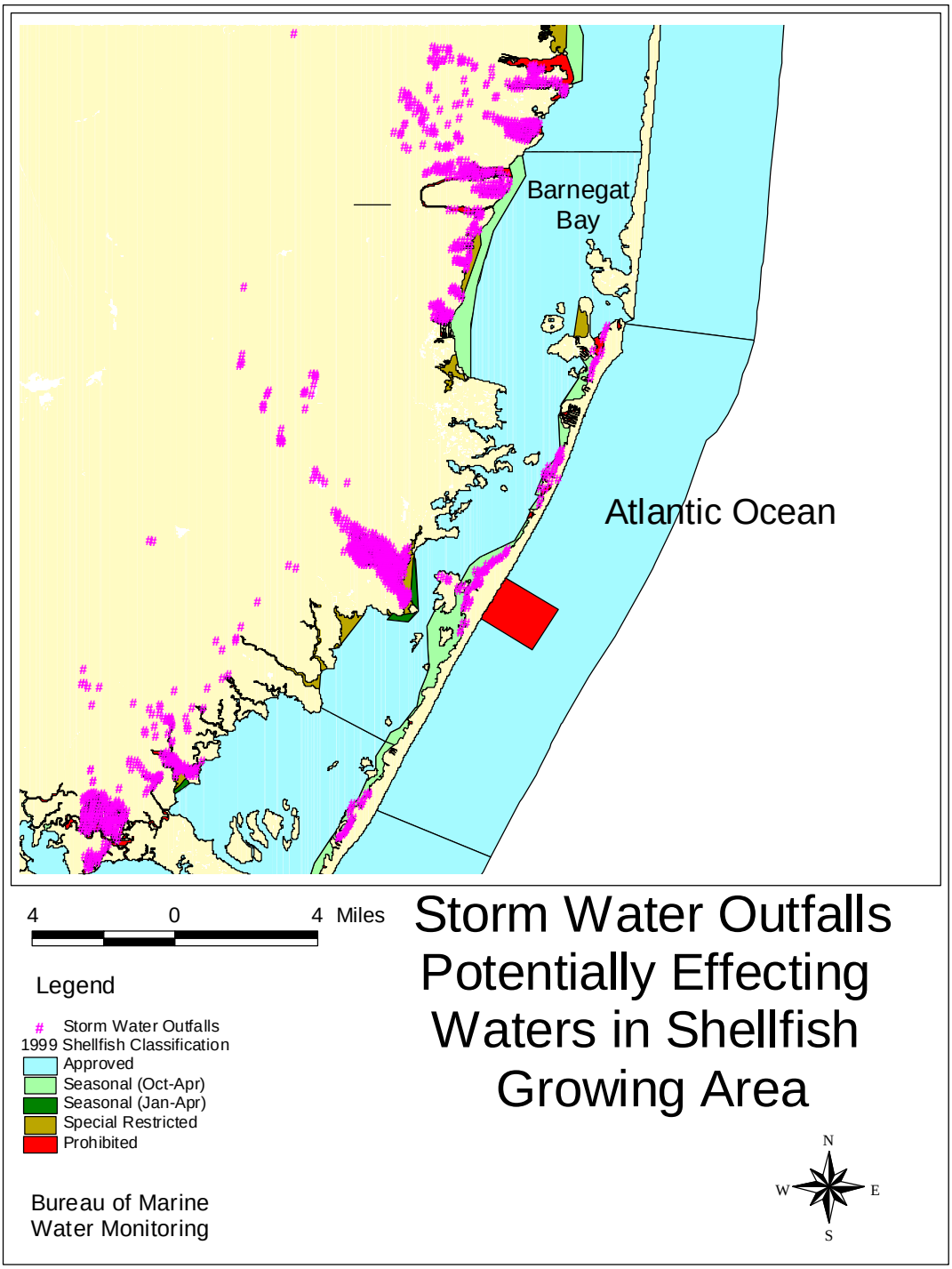
The facility has a NJPDES Permit, number NJ0005550, which allows them to discharge non-contact cooling water from the operation of the plant, storm water runoff, and water from a sump pump in the basement of the generating facility. The water from the sump pump has some contamination from radioisotopes. The practice of discharging the "hot" water from the sump pump has been discontinued for the past ten years, although the NJPDES Permit still covers this water. The water from the sump pump is currently disposed of along with radioactive waste from the operation of the facility.

There is a horseshoe shaped canal connecting Forked River and Oyster Creek which functions to provide non-contact cooling water for this facility. One million gallons per minute flow through the canal. Of this, 115,000 GPM (gallons per minute) are pumped out of the canal for use as non-contact cooling water, using four (4) pumps, and then replaced a few meters later, with water containing thermal impacts. The NJPDES Permit for this facility allows the non-contact cooling water to have a temperature increased no more than 23^{o} F over the ambient temperature of the receiving water, with a maximum of 106^{o} F. The average increase in temperature is 20^{o} F. During periods of high temperature in the summer, the ambient temperature of the water often raises to a point where the added thermal impact would raise the temperature of the discharged water over 106^{o} F. During these periods, the facility decreases its operation. The water which is extracted for use as non-contact cooling water is also chlorinated to prevent biogrowth from clogging the pipes. The NJPDES Permit for this facility sets the limit of .2 ppm for the discharged water.

This facility is required by its operation permit to test the local environment for impacts from radiation. An annual report is compiled and submitted to United States Nuclear Regulatory Commission. The materials tested include soil, air particulates, stream and bay sediments and shellfish, crustacean and finfish flesh. The two primary isotopes examined are Cobalt – 60 and Cesium – 137. Background samples are taken from Great Bay for comparison.

INDIRECT DISCHARGES

FIGURE 10: STORM WATER OUTFALLS IN SHELLFISH GROWING AREA



In addition to the direct discharge from the nuclear generating facility already discussed, significant impact to the area comes from indirect discharges through non-point sources. The primary conduits for the non-point sources to reach this shellfish growing area are storm water outfalls. There are numerous storm water outfalls located along the shoreline and along the streams and waterways which empty into this area. Runoff from rain events can carry a variety of materials including fecal waste from domestic pets and feral animals living in proximity to the urban areas, such as birds, squirrels and raccoons. The runoff may wash down additional material such as waste from road kill, petroleum products spilled from automobiles and fertilizer from manicured lawns in urban areas.

In the wetland areas, as well as the forested lands upstream, populations of feral animals, such as flocks of birds, deposit fecal waste which can be picked up in storm water runoff. Flocks of waterfowl can deposit fecal waste directly into the waters of this area in the proximity of the wetlands. The storm water runoff in this area is not channeled to storm drains, but flows over land and into streams. The flow of water though the large area wetlands cleanses the waters of this area by the waste providing nutrients for plant growth in the wetlands. Storm water runoff is not as large an issue in the wetland regions of this area as in the urban developed region.

Another possible source of impact to the waters of this area originates from the extensive wetlands areas. The wetlands have been extensively ditched for many years as part of efforts to control mosquito populations. The history and present use of pesticides utilized in the efforts to control mosquito populations are not assessed in this report, however it should be noted that potential for impacts exist.

On February 23, 2000, Steven Peters, Environmental Specialist, performed a routine investigation of the shoreline in this area. One of the dominant features of the area is the presence of several lagoon communities. The largest lagoon community in this area is Beach Haven West in Manahawkin. As already discussed, lagoon communities are residential developments which have dredged lanes of lagoons which allow waterborne access to the bay for all residents of the community. The canals in a lagoon community can have significant contamination from storm water runoff and boat usage by the residents in the lagoon communities.

Due to direct access to water for all the residents of these communities recreational boat usage can be extensive and significant impacts can occur from the boat use. The impacts include spills of petroleum products from the motors and fueling of the boat and cleaning materials and paints used for maintenance of the boats. These impacts can be more significant during the summer months when population in this area increases due to tourism and more recreational boating is pursued.

In addition, the preserved wood used to make the docks in the lagoon communities, and along regular streams as well, can deposit various heavy metals into the water. The heavy metals, such as Chromium, Arsenic and

Cadmium, are used as the preservative in the wood. As the wood decays, the heavy metals leach out into the water. Also, hydrocarbons which impact the water can oxidize creating polyaromatic hydrocarbons, many of which are known carcinogens. These impacts are centered around the lagoon communities and marinas, due to large amount of docks which are present in these areas.

The canals in lagoon communities are classified as *Prohibited* waters and all the lagoon communities have buffers around them to prevent impacts to *Approved* waters. The buffers may be *Prohibited*, *Special Restricted* or *Seasonally Approved* waters depending on the likelihood of pollutants impacting *Approved* waters from that community.

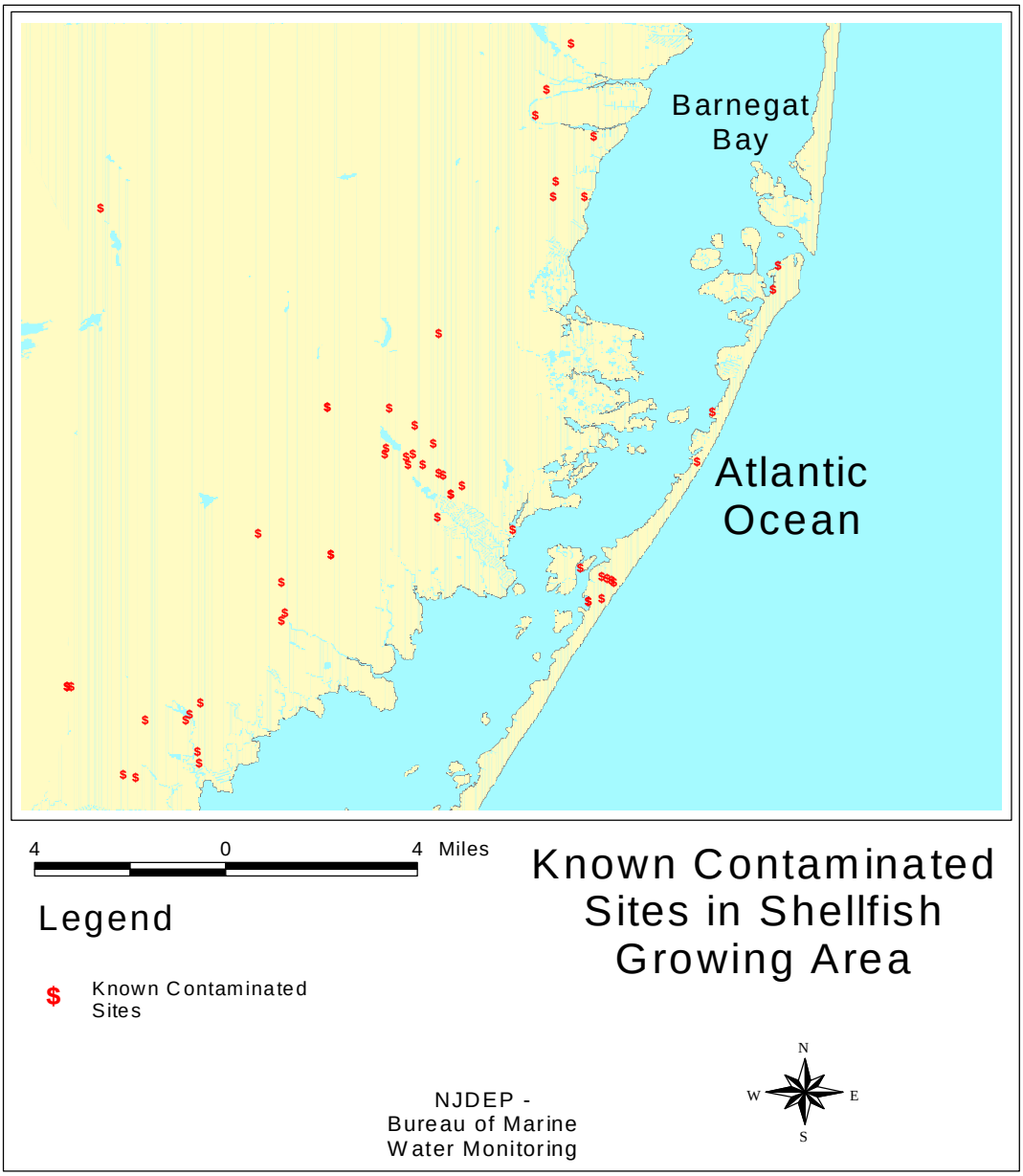
FIGURE 11: CANAL AT BEACH HAVEN WEST, LAGOON COMMUNITY IN MANAHAWKIN

In addition, potential sources of chemical contamination are located throughout this area. Known contaminated sites are located scattered through the area. Few are located in close proximity to the shoreline. Those which are located in proximity to the shoreline are primarily service stations which had underground storage tanks which leaked. Remedial action to eliminate any contamination is required of the responsible parties at each of these locations. Any contaminants that were discharged to under ground soil from tanks are unlikely to impact the marine waters of this area. The contaminants would have been absorbed by the soils surround the underground storage tank.

The contaminants are unlikely to migrate to marine waters.

Due to the nature of the material discharged by the underground storage tanks being petroleum fuels, it is unlikely that any deleterious effects to the bacterial safety of the shellfish of this area would originate from these sources. Additionally, in the unlikely case that any of these sources were impacting the marine waters of this area, there would be minimal impact to shellfish from petroleum products. Petroleum does not mix well with water, tending to float on top of the water column, while shellfish are present at the bottom of the water column.

FIGURE 12: KNOWN CONTAMINATED SITES IN SHELLFISH GROWING AREA



A major source of interaction of waters in this area is Barnegat Inlet. Waters on both sides of the inlet are classified as *Approved*. It is unlikely that any impacts would enter this area from the *Approved* Atlantic Ocean waters on the other side of the inlet. The interaction with the Atlantic Ocean waters provides mixing and dilution for waters of this area, helping to maintain good water quality for the waters of the area. There is also interaction with Atlantic Ocean waters for this area through Little Egg Inlet, which is to the south in the next area.

FIGURE 13: BARNEGAT INLET

The waters immediately adjacent to shoreline where urban development exists can receive impacts from runoff which enters the waters. Tidal exchange can move pollutants into water further from the shore. Most of the stations impacted by tidal exchange are near the areas where urban development which are near the inlet. The regions of *Seasonally Approved* waters which line the urban developed regions of this area help to prevent impacts to water during the time period when these impacts would be the greatest. This will be discussed further in the section on hydrography and meteorology, on page 29.

Marinas

Marina facilities have the potential to effect the suitability of shellfish growing areas for the harvest of shellfish. The biological and chemical contamination associated with marina facilities may be significant for public health considerations. New Jersey defines a marina as "any structure (docks, piers, bulkheads, floating docks, etc.) that supports five or more boats, built on or near the water, which is utilized for docking, storing, or otherwise mooring vessels and usually but not necessarily provides services to vessels such as repairing, fueling, security or other related activities" and designates the confines of the marina as *Prohibited* for the harvest of shellfish. Adjacent waters are classified utilizing a dilution analysis formula.

It is recognized by the NSSP *Guide for the Control of Molluscan Shellfish,* 1997, that there are significant regional differences in all factors that affect marina pollutant loading. The manual therefore allows each state latitude in applying specified occupancy and discharge rates. The NSSP guidelines assume the worst case scenario for each factor.

EQUATION 1 :MARINA BUFFER EQUATION. (ADAPTED FROM FDA. 1989):

$$BufferRadius(ft) = \sqrt{\frac{2x10^{9}(FC/person/day)x2(person/boat)x[(.25slips \geq 24') + (0.065 \times slips < 24')]x2}{140000(FC/M^{3})xdepth(ft)x0.3048(M/ft)xpx2(tides/day)}} x3.28(ft/M)$$

Explanation of terms in equation:

Fecal coliform per person per day:	2×10^{9}
Number of people per boat:	2
For slips able to accommodate boats > 24 feet (combination of factors yields multiplier of 0.25):	
Number of slips occupied:	50%
Number of boats occupied:	50%
For boats < 24':	6.5% discharge waste
Angle of shoreline:	180^{o}, which results in factor of 2
Number of tides per day:	2
Depth in meters:	depth in feet x conversion factor
Water quality to be achieved:	140000 FC/meter ^{3}
Convert meters to feet:	3.28

Marina buffer zones may be calculated using the formula above, or may be determined using a dilution analysis computer program developed by the State of Virginia and the USFDA. The formula above considers only dilution and occupancy rates. The computer program, which is used for complex configurations where the formula is unlikely to provide the needed accuracy, also considers tidal exchange and bacterial die-off.

There are 46 marinas in this area, as shown in Table 2. The marinas are spread throughout the shorelines of most of this area. The majority of the marinas are located along the sporadic urban developed areas along the northwestern shoreline of this bay area. There are also several marinas along the southeastern

shoreline of the bay on the southern barrier island which is developed for urban land use. There are no marinas on the northern barrier island, which is a state park. The largest clusters of marinas are located in the areas of the lagoon communities near Forked River and Beach Haven West in Manahawkin.

The waters enclosed by the marinas are classified as *Prohibited*; depending on the size of the marina and the water quality, water immediately adjacent to each marina may be classified as *Prohibited*, *Special Restricted*, or *Seasonally Approved* (no harvest during summer months when the marina is active). Marina buffer zones were calculated using the equation above. The size of each buffer zone is shown in Table 2.

FIGURE 14 : MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA

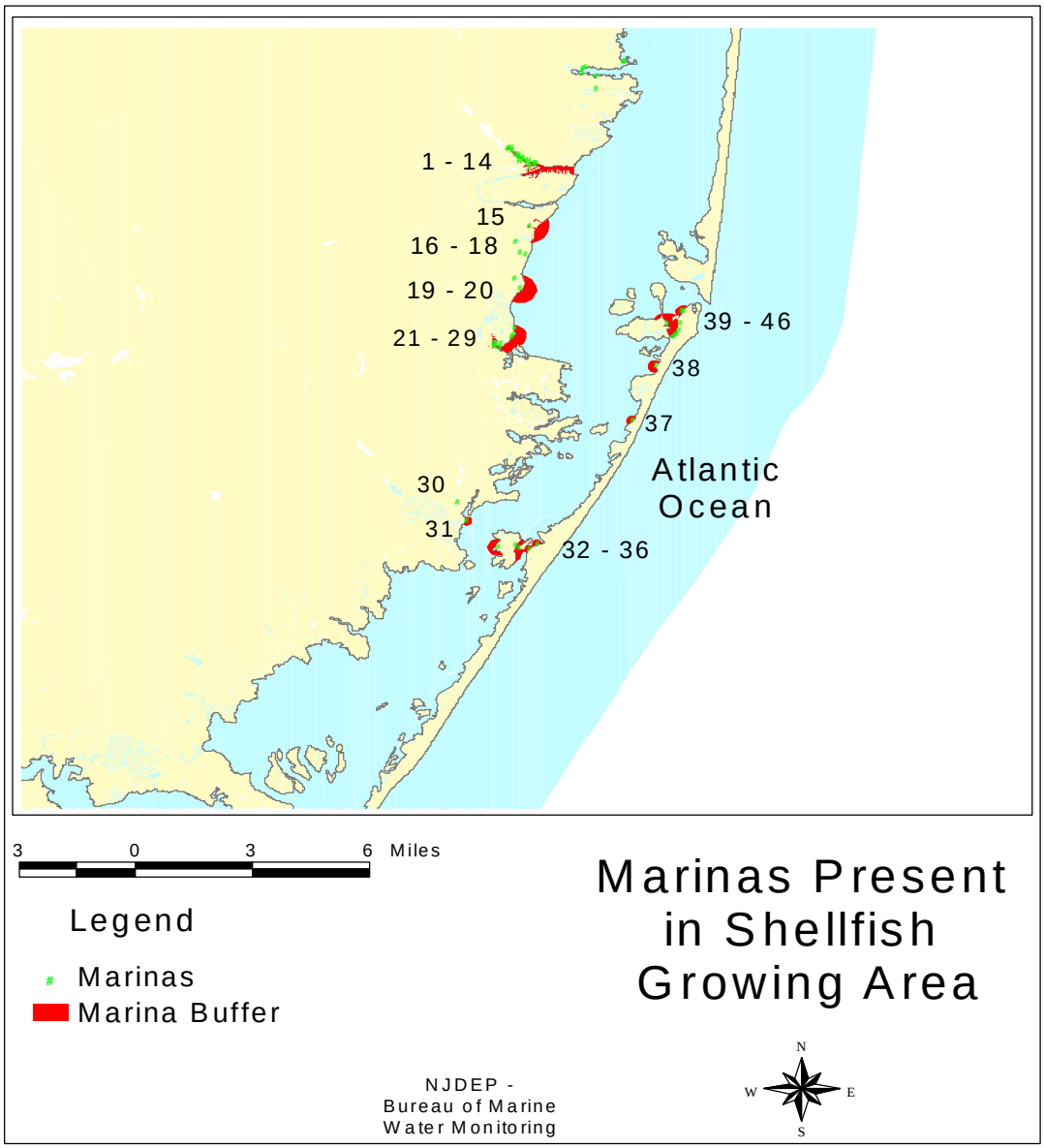


TABLE 2: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA

Map Key	Marina Name	Total # of Slips / # of Slips over 24 ft	Size of Buffer Area (radius; feet)
1	Forked River State Marina	125 / 115	1086
2	Wilbert's Marina	17 / 17	442
3	Silver Cloud Marina	54 / 54	787
4	River Lights	39 / 39	560
5	Tall Oaks Marina	124 / 124	1193
6	Grant Boat Works	50 / 50	757
7	Ted &Sons Marina	50 / 40	654
8	Tide's End Marina	31 / 31	596
9	Rivers Edge Marina	30 / 25	593
10	Townsends Marina	100 / 100	1002
11	Rick's Marina	81 / 81	902
12	Forked River Township Marina	11 / 11	332
13	Captain's Inn	30 / 30	549
14	Southwind Marina	145 / 145	1206
15	Holiday Harbor Marina	200 / 200	2834
16	Long Key Marina	124 / 40	1114
17	Sanborn Marine Center	200 / 75	1469
18	Mac's Dock	8 / 8	463
19	Leaming's Marina	76 / 31	1309
20	Cape Island Marina	265 / 187	2355
21	Mystic Sailing Port	8 / 8	463
22	Iggie's Dock and Marina	135 / 135	1901

23	Bob’s Bay Marina	82 / 82	1481
24	Mariners Marina	142 / 142	1949
25	Bob’s Dockage	9 / 9	491
26	Sherer’s Boat Basin	60 / 60	1267
27	Barnegat Boat Basin	13 / 13	590
28	East Bay Marina	29 / 29	881
29	Dirb Boats	20 / 20	732
30	Hance & Smythe, Inc.	20 / 20	732
31	Margo’s Inn	40 / 40	732
32	Causeway Rentals	300 / 100	1426
33	Duck Inn & Marina	50 / 50	1417
34	Duke’s Boat Rental	9 / 9	601
35	Hochstrasser’s Marina	70 / 70	790
36	Surf City Marina	71 / 71	755
37	The Boat Yard	18 / 18	850
38	Loveladies Marina	50 / 50	1002
39	Viking o Villageals	30 / 30	896
40	Barnegat Light Yacht Club	54 / 54	1202
41	Inlet Marine Sales	38 / 38	1008
42	Bayview Marina	45 / 45	1097
43	High Bar Marina	150 / 150	2004
44	Ed’s Boat Rental	58 / 58	1246
45	Lighthouse Marina	80 / 80	1035
46	Henry’s Boat Rental	12 / 12	401

Spills or Other Unpermitted Discharges

There were no spills that resulted in closure of the waters of this area recorded during the time period covered in this report.

HYDROGRAPHY AND METEOROLOGY

There are several different land uses in the areas surrounding this bay area. The different types of land use result in varying hydrology through the area. The land uses that occupy the majority of the land in proximity to the waters of this area are urban and wetland.

There are numerous regions of wetlands around this area. In the southern section of this area the Edwin Forsythe National Wildlife Refuge holds the majority of the inland shoreline as protected wild area. The barrier island in the northeastern part of this area is also largely protected wetlands area, Island Beach State Park. The shoreline throughout this wildlife refuge and state park is composed of wetlands. Wetlands tend to function to clean water by utilizing pollutants as nutrients for plant growth. The presence of significantly large regions of wetlands in this area may contribute to the good water quality which results in *Approved* waters constituting the majority of acreage in this area. There may be impacts from the wetlands areas due to the presence of populations of feral animals, in particular flocks of water fowl, which may deposit fecal material that impacts the waters of the area. However, the actions of the wetlands in general help to maintain high quality for the water in this area.

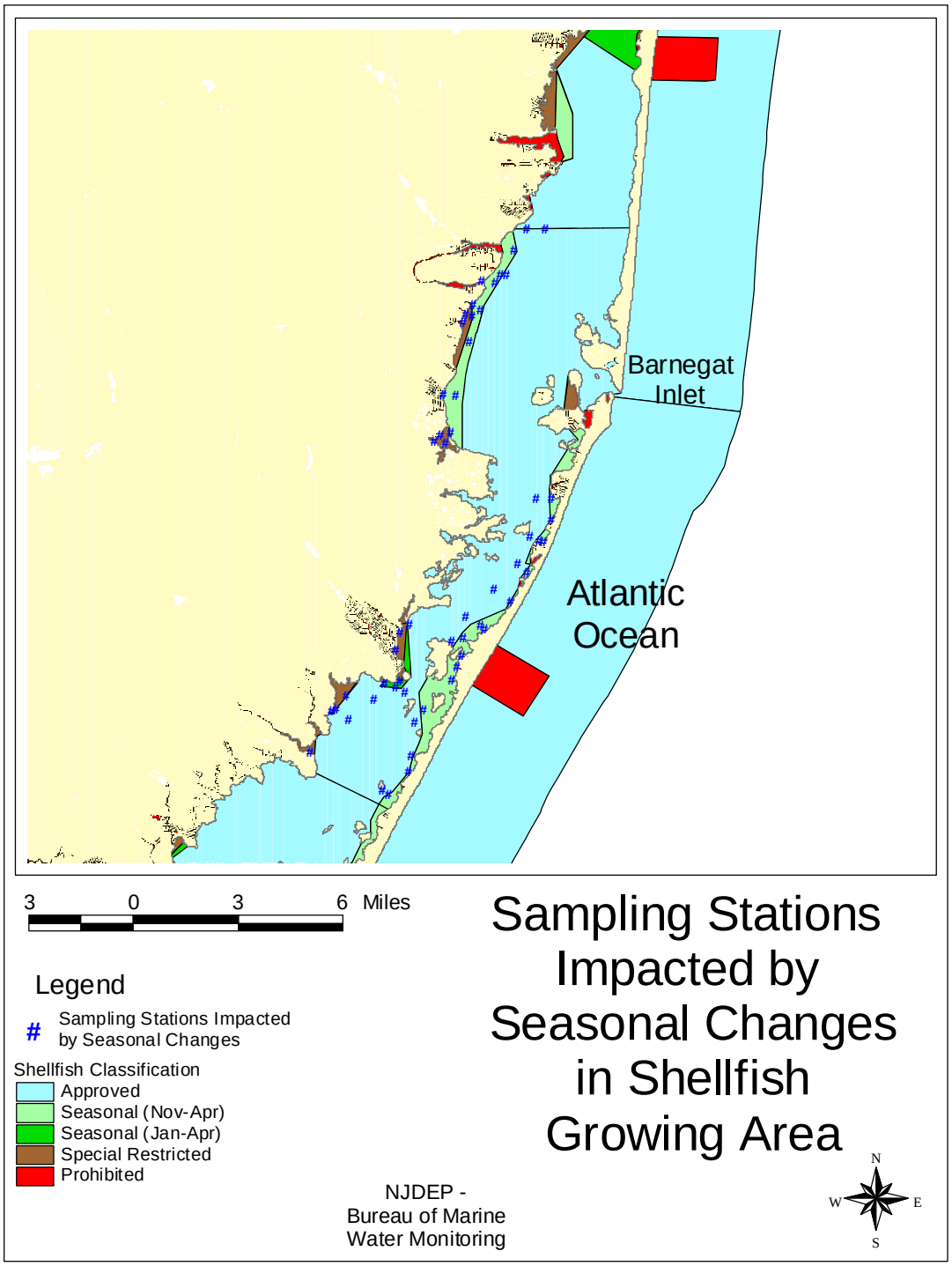
Urban development dominates the barrier island on the southeastern part of this area and mainland shoreline in the northwestern part of this area. The urban development results in large amounts of storm water runoff. The storm water is collected and drains to storm water outfalls. The storm water outfalls empty into the back bay waters of this area, away from the ocean waters.

Many of the urban developed lands in this area experience significant seasonal fluctuation in population. During the summer months, increased population results in increased impacts to the waters of this area due to storm water run off carrying greater amounts of domestic pet fecal waste, petroleum waste and other waste residual. This is why most of the urban developed lands in this area have sections of *Seasonally Approved* waters located near them. The *Seasonally Approved* waters prevent shellfish harvesting during the summer months when impact would be the greatest.

The following map depicts the sampling stations that were impacted by seasonal changes. It is evident that all the seasonally impacted sampling stations are located along the areas of where more urban development is present. This demonstrates the impacts of the population fluctuations in the urban developed areas. These areas are buffered with areas *of Seasonally*

Approved areas which prevent harvesting of shellfish during the summer months, when the impacts would be the greatest.

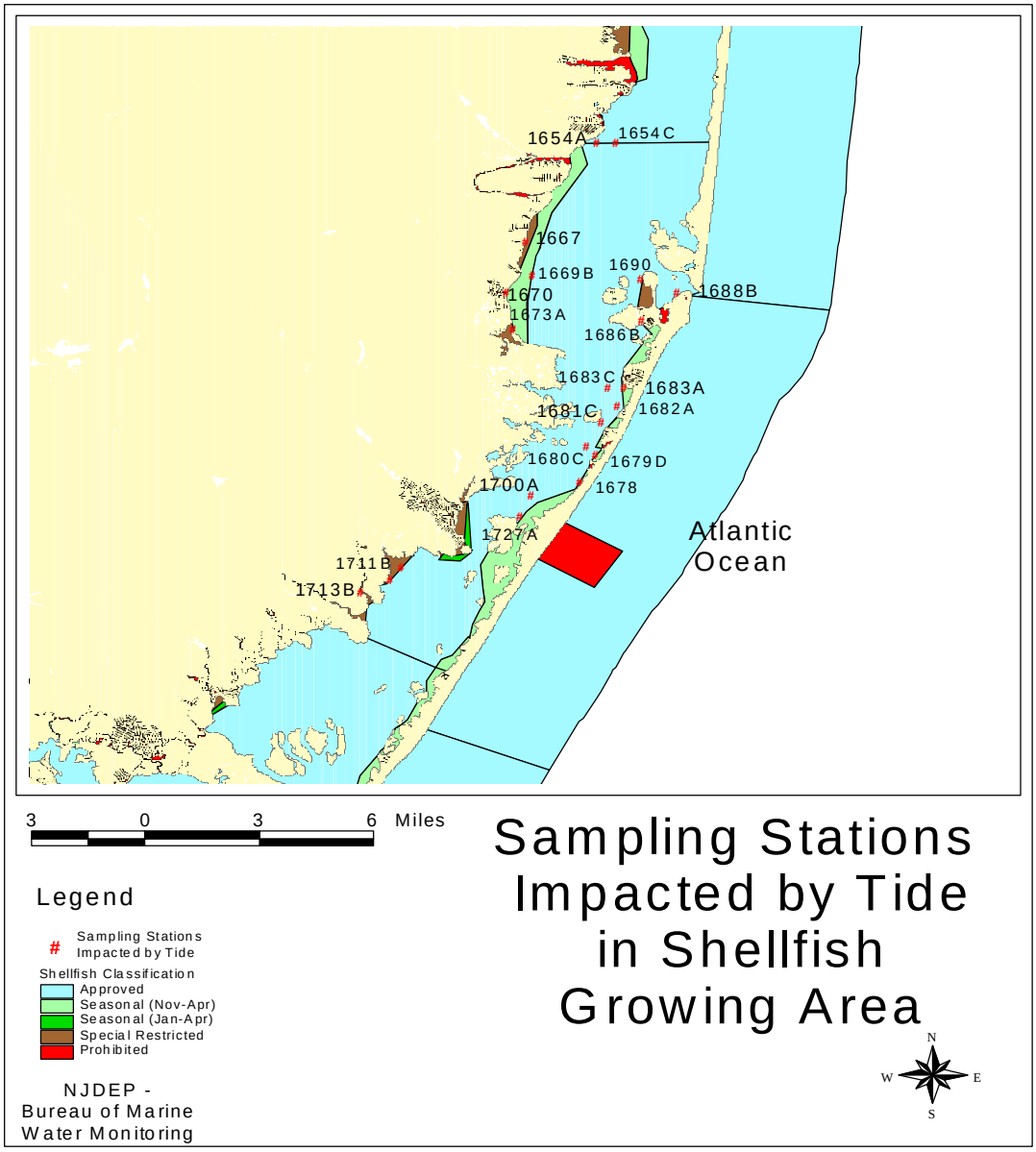
FIGURE 15: SAMPLING STATIONS IMPACTED BY SEASONAL CHANGES IN SHELLFISH GROWING AREA



This area is a large bay area which receives water inputs from 18 streams and rivers, such as Forked River and Oyster Creek. Most of the streams have their headwaters west of the Garden State Parkway, though some originate closer to the shoreline. Most of the streams have been identified as not having a significant bacteriological loading with potential to impact marine waters. However, a few larger streams and rivers which have urban development surrounding them can carry impacts from storm water runoff due to the presence of numerous storm drains. This is especially true of lagoon communities such as those near Forked River and Oyster Creek in the north and Beach Haven West near Mill Creek in the south. Lagoon communities are residential developments where small water lanes are dredged to reach all the houses. These developments can input significant amounts of storm water runoff which carries pollutants. The areas of this type which have potential to cause impacts are surrounded by buffer zones of *Special Restricted* and *Seasonally Approved* waters to prevent impacts to *Approved* waters.

This bay area also has tidal exchange with the Atlantic Ocean through Barnegat Inlet. Tidal exchanges provides a mechanism to mix impacted water with higher quality water Significant amounts of mixing and dilution occur for the waters in this area, evidenced by the generally high water quality and the majority of the waters being classified as *Approved*. However, the waters immediately adjacent to shoreline where urban development exists can receive impacts from runoff which enters the waters. Tidal exchange can mix these waters with those further from the shore. The following map shows stations impacted by tidal exchange near the areas where urban development results in increased impacts to the water. The regions of *Seasonally Approved* water provide an additional measure of safety during the time period when these impacts would be the greatest.

FIGURE 16: SAMPLING STATIONS IMPACTED BY TIDE IN SHELLFISH GROWING AREA



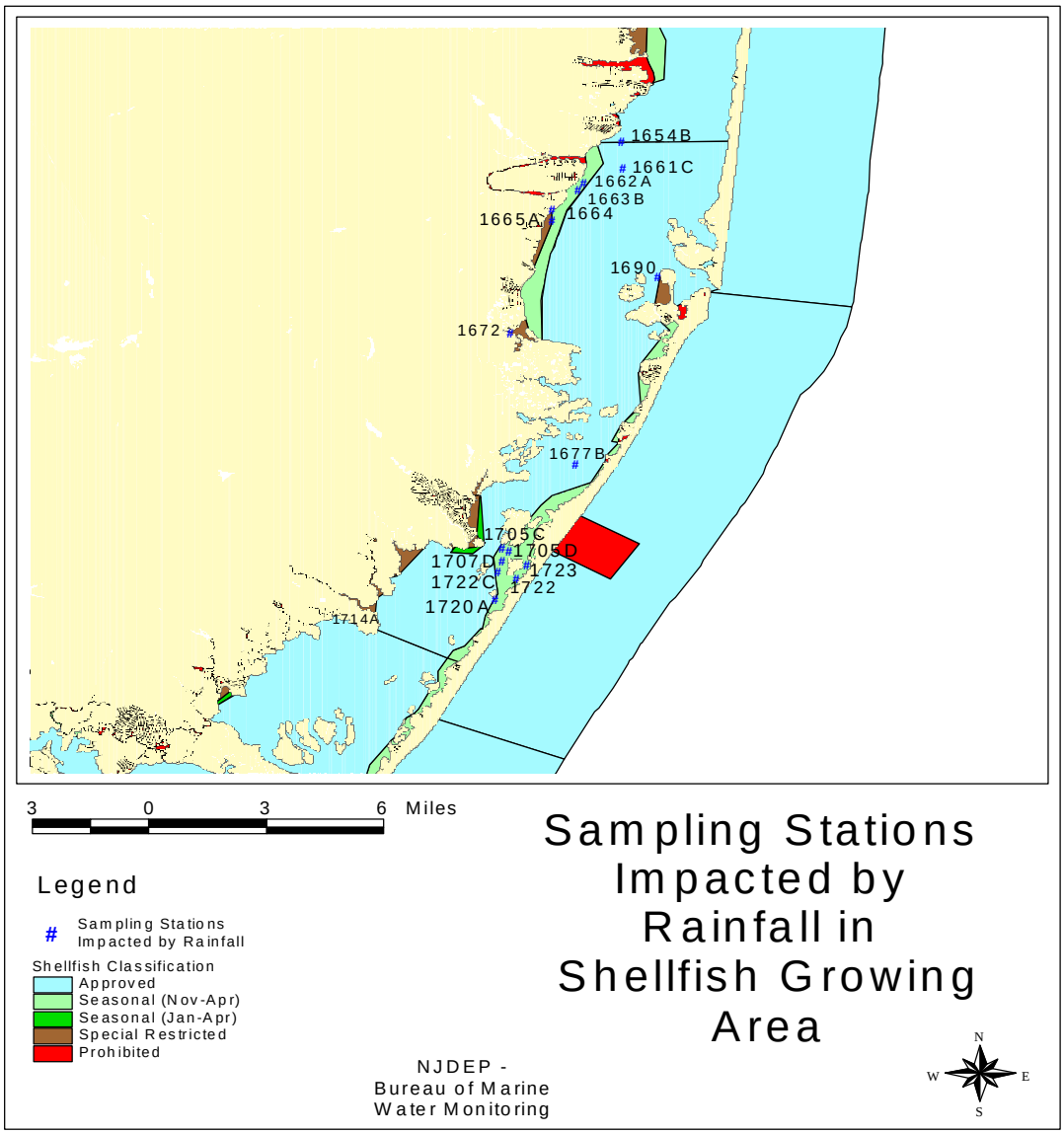
There have been no significant changes in hydrography since the last Sanitary Survey in 1988. The primary weather station for this area is Brant Beach in Ship Bottom. The secondary weather station for this area is Atlantic City Airport. The secondary station data is used when data from the primary station are incomplete.

There are no indications that any large storms, hurricanes or severe winter cyclonic events (nor'easters), caused conditions of elevated coliform levels in the area. In 1999, a large hurricane hit New Jersey, Hurricane Floyd, but the majority of the intensity was focused on the western and northern parts of the state. In 1996, a hurricane which had lost intensity went through New Jersey.

Large storms were not significant for determining impacts to shellfish in this area.

There were a few sampling stations which had results which indicated impact from precipitation. Most of these stations area clustered around areas with urban development. This demonstrates the impacts of storm water runoff from areas where urban development contributes loads of contaminants such as droppings from domestic pet animals and petroleum hydrocarbons from automobile exhaust and leakage of the automobiles. The regions which are most heavily impacted have areas of *Seasonally Approved* waters surrounding them to prevent harvesting of shellfish during the time when the impacts would be greatest.

FIGURE 17: SAMPLING STATIONS IMPACTED BY RAINFALL IN SHELLFISH GROWING AREA



It should be noted that significant impacts due to hydrography in this area are focused around regions of urban development. Runoff from the urban areas empties to the bay waters during storms and gets pulled out with changing tides. These impacts are greater during the summer season due to increased population during the summer months when tourism is at its height. The presence of the *Seasonally Approved* classified areas which line most of the urban areas help to ensure safety of harvested shellfish by preventing harvest during the summer season when impacts would be greater. During the winter, the decreased population allows for harvesting without the risks of impact in the waters close to the bay shores of the urban areas.

FIGURE 18: 1999 HURRICANE TRACKING MAP

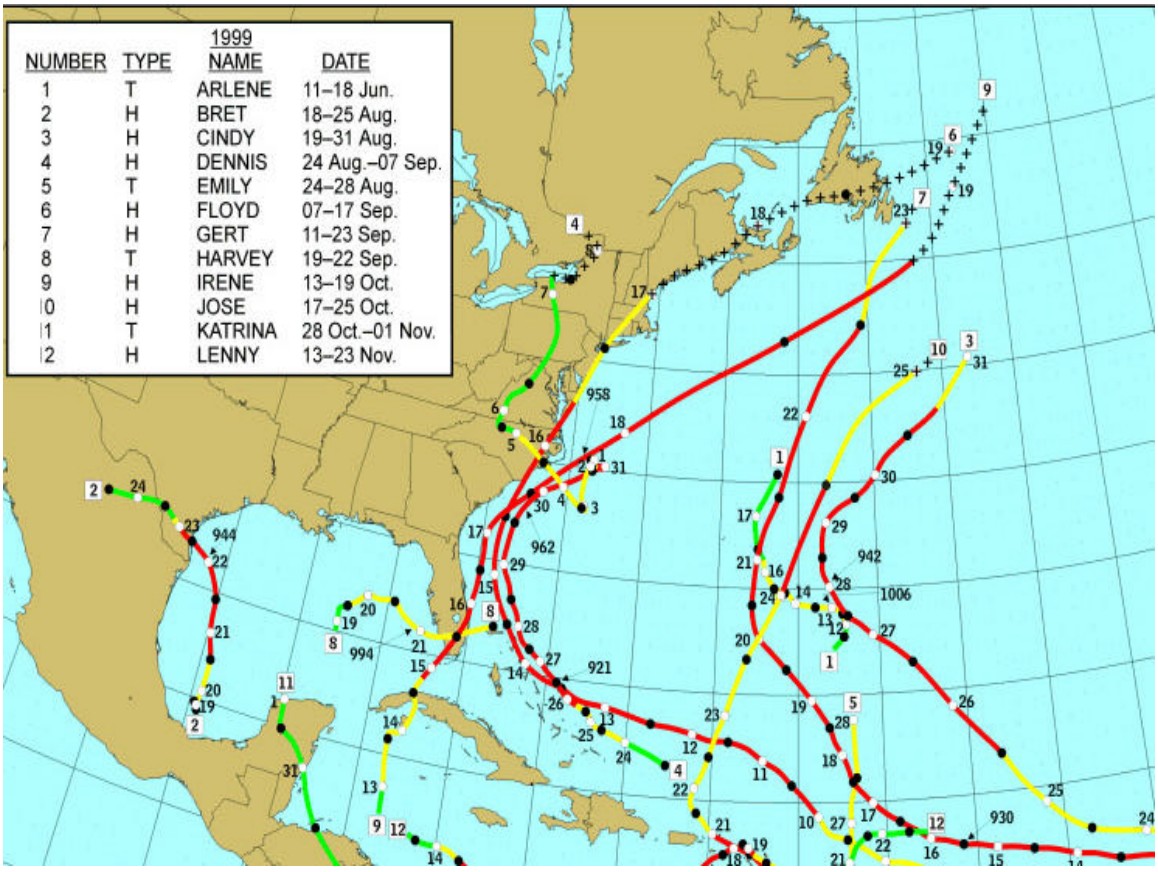


FIGURE 19: 1998 HURRICANE TRACKING MAP

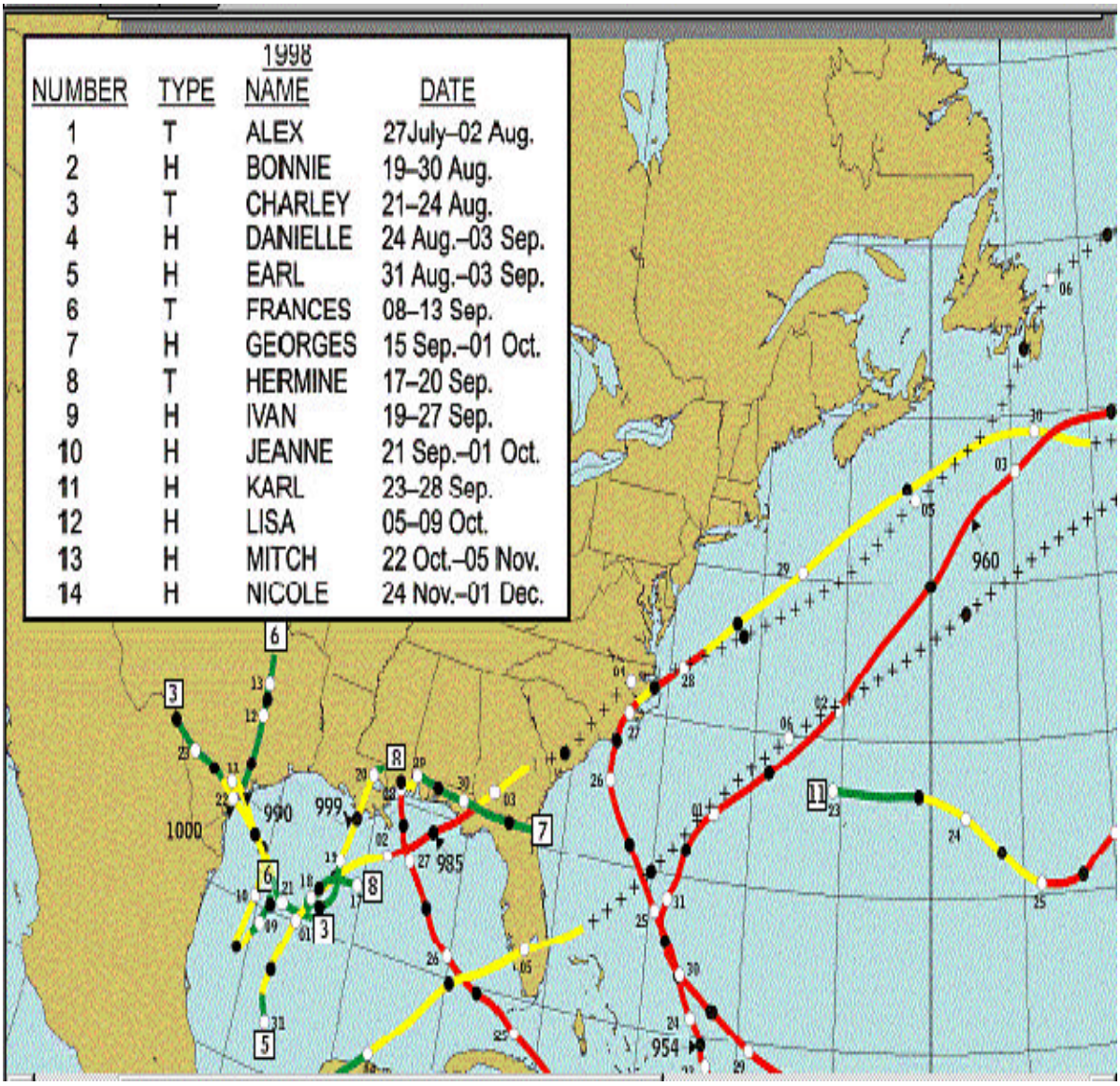


FIGURE 20: 1997 HURRICANE TRACKING MAP

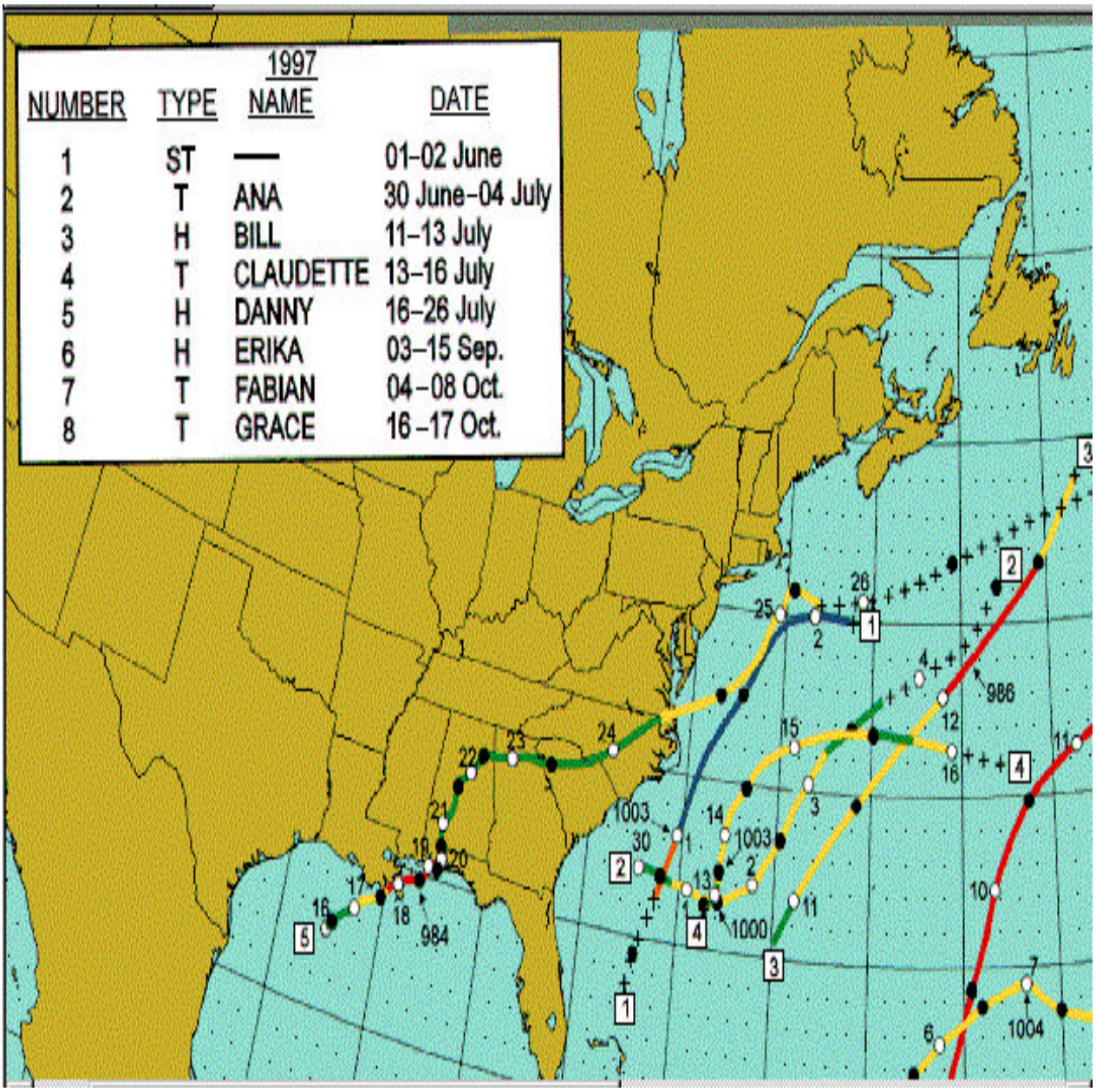


FIGURE 21: 1996 HURRICANE TRACKING MAP

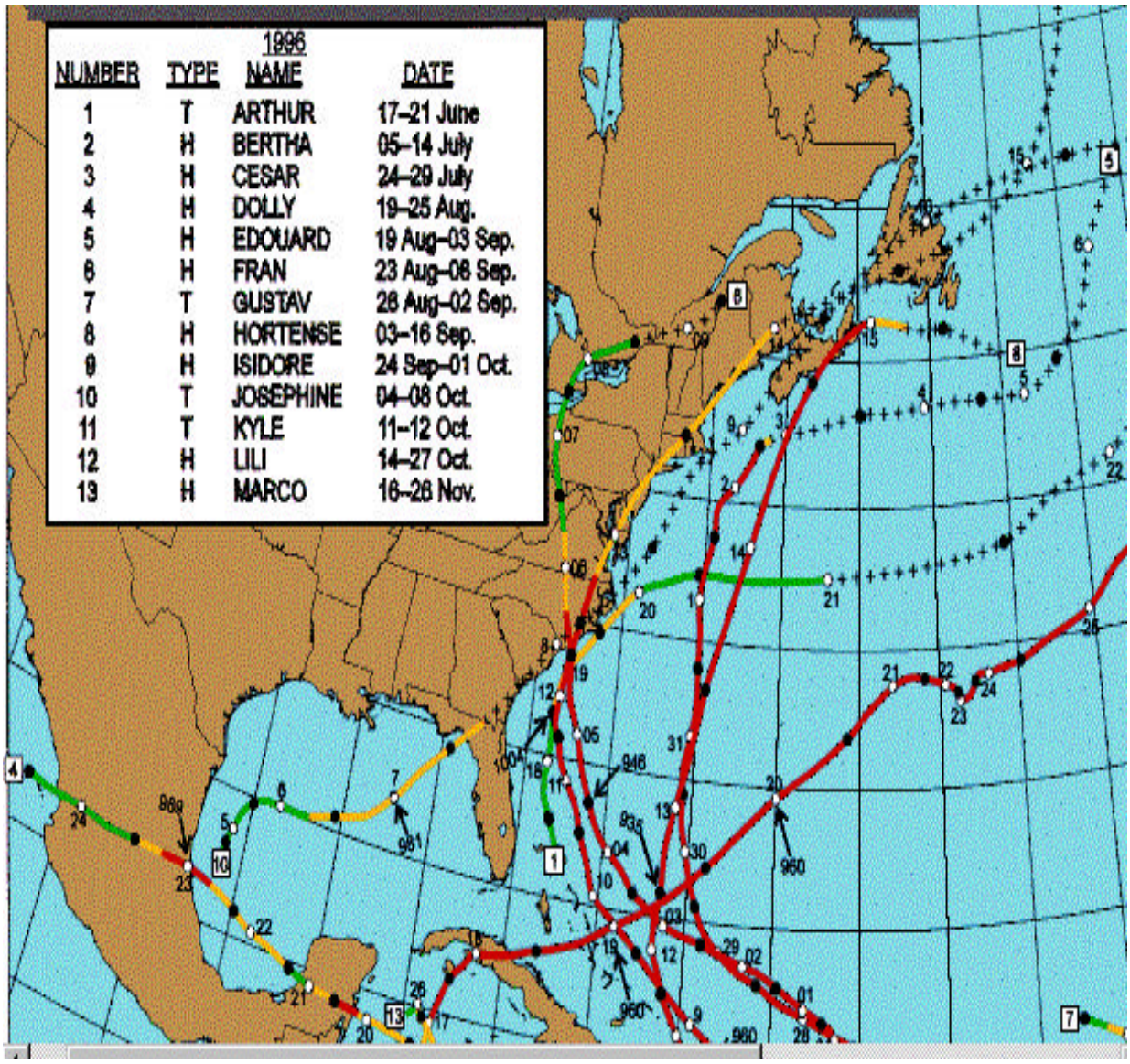


FIGURE 22: 1995 HURRICANE TRACKING MAP

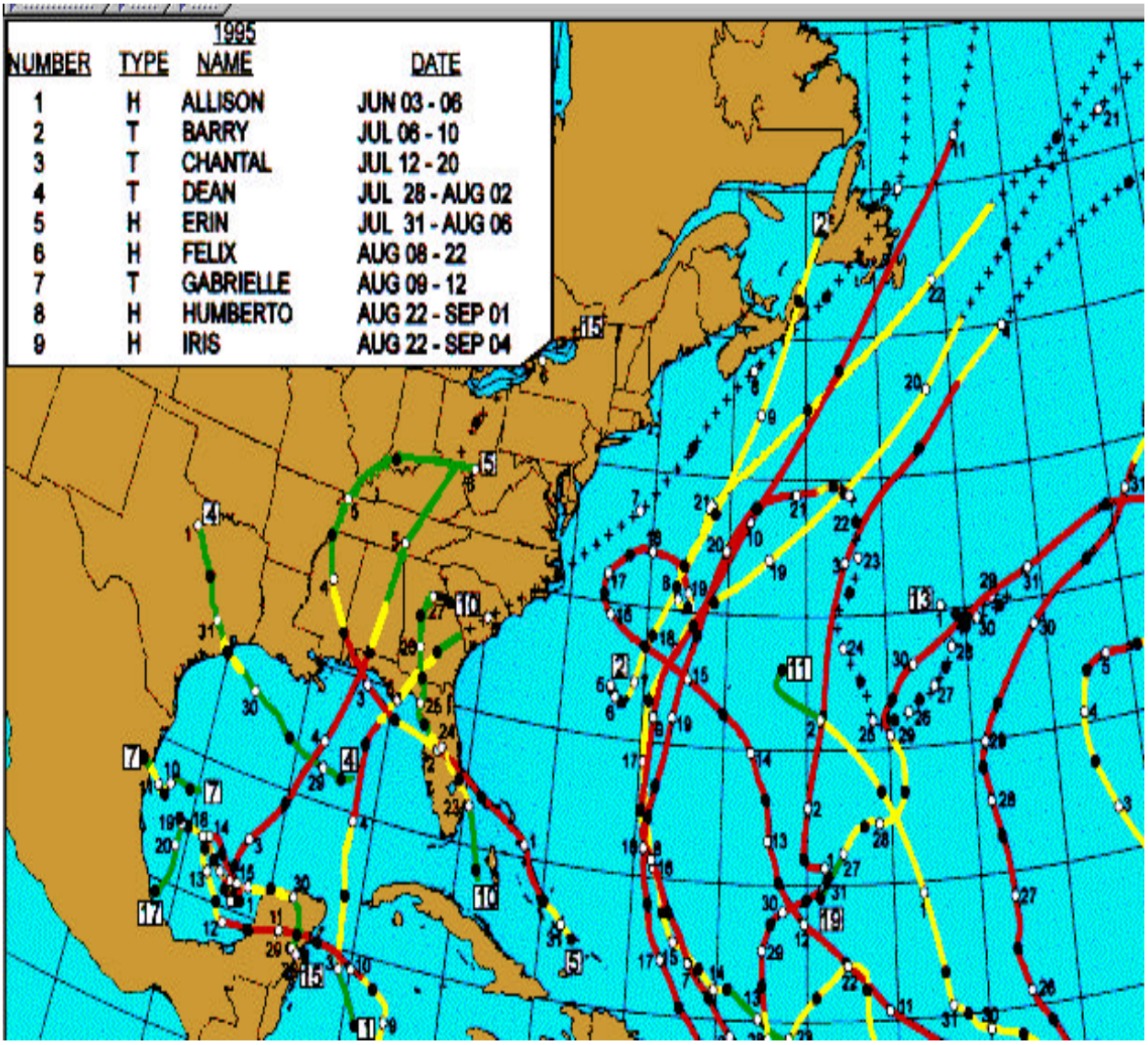


TABLE 3: CLIMATOLOGICAL DATA

Rainfall Recorded at NOAA's Brant Beach, Ship Bottom Station at 0800 hrs.
Some missing data was substituted with data from NOAA's Toms River Station

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
1/9/95	0	0.03	1.31
1/13/95	0	0	0.07
1/17/95	0.05	0.44	0.44
1/23/95	0	0	0.11
2/27/95	0.03	0.04	0.04
2/28/95	0.46	0.49	0.5
3/1/95	0.4	0.89	0.98
3/3/95	0	0	0.4
3/6/95	0	0	0
3/10/95	0	0.95	0.95
3/17/95	0	0	0
3/22/95	0	0.32	0.32
4/10/95	0.12	0.17	0.17
4/12/95	0.02	0.02	0.14
4/25/95	0	0.12	0.22
4/26/95	0	0	0.12
4/27/95	0	0	0
4/28/95	0.63	0	0
5/3/95	0.45	0.45	1.69
5/5/95	0	0	0.45
5/22/95	0	0	0
5/24/95	0	0	0
6/16/95	0	0.005	0.305
7/11/95	0.8	0.8	0.8
7/12/95	0	0.8	0.8
7/13/95	0	0	0.8
8/8/95	0	0.83	0.93
8/9/95	0	0	0.83
9/12/95	0	0	0
9/13/95	0	0	0
10/3/95	0	0	0
10/4/95	0	0	0
10/10/95	0	0	0
10/19/95	0	0	0
10/31/95	0	0	0
11/3/95	0.1	0.4	0.4
11/16/95	0	3	3.07
11/17/95	0	0	3
11/28/95	1.1	1.15	1.15
11/30/95	0	1.1	1.1

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
12/6/95	0.2	0.2	0.47
12/7/95	0	0.2	0.2
1/25/96	0.25	0.25	0.25
1/26/96	0	0.25	0.25
1/29/96	0	1.4	1.4
2/1/96	0.11	No Data	No Data
2/23/96	0	0	0.35
3/6/96	0.1	0.1	0.15
3/7/96	0.75	0.85	0.85
3/20/96	0.7	0.7	0.7
3/25/96	0	0	0
4/8/96	0.43	0.435	0.435
5/6/96	0.41	0.51	1.26
5/20/96	0	0	0.01
6/4/96	1.18	1.18	1.18
6/18/96	1.42	1.42	1.42
7/9/96	0.27	0.27	0.27
7/17/96	0	0	0
7/18/96	0	0	0
7/22/96	0.01	0.01	0.4
8/5/96	0	0	0
8/14/96	1.5	2.9	2.9
8/20/96	0	0	0.49
8/27/96	0	0	0.02
10/1/96	0	0	0.6
10/9/96	1.97	2.6	2.6
10/16/96	0	0	0
10/21/96	0.02	3.31	3.51
10/23/96	0.01	0.03	0.11
10/28/96	0	0	0
10/30/96	0	0.35	0.51
11/6/96	0	0	0
11/13/96	0	0	0
11/20/96	0	0.16	0.16
12/2/96	1.65	1.7	1.7
12/4/96	0	0.08	0.87
12/5/96	0	0	0.08
12/11/96	0	0	0.04
12/18/96	0.04	0.24	0.24
1/9/97	0.02	0.02	0.02
1/13/97	0	0	0.2
2/3/97	0.005	0.005	0.205
2/5/97	0.98	0.98	0.98
2/18/97	0	0	0.04
2/24/97	0	0.04	0.05
2/26/97	0	0	0
2/28/97	0	0	0.15
3/5/97	0.1	0.15	1.3

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
3/12/97	0	0.01	0.52
3/17/97	0	0	0.65
3/18/97	0	0	0
4/2/97	0	0.02	0.61
4/3/97	0	0.15	0.61
4/10/97	0	0	0
4/14/97	0	0.62	0.62
4/22/97	0	0	0.03
4/23/97	0.87	0.87	0.87
4/25/97	0.12	0.87	0.87
5/13/97	0	0	0.05
6/9/97	0	0	0
6/11/97	0	0	0
6/19/97	0.08	0.08	0.08
7/14/97	0	0	0
8/14/97	0.59	0.59	0.59
8/25/97	0	0	0
10/8/97	0	0	0
10/15/97	0.12	0.12	0.12
10/16/97	0.31	0.43	0.43
10/20/97	0	0	0.10
10/22/97	0	0	0.31
10/24/97	0	0	0
10/27/97	0.9	0.905	0.91
10/29/97	0	0.005	0.905
11/3/97	0.08	0.83	0.85
11/6/97	0	0	0
11/10/97	0.08	0.63	1.18
11/18/97	0	0	0.04
11/19/97	0	0	0
11/20/97	0	0	0
12/3/97	0	0	0.28
12/4/97	0.25	0.25	0.25
12/8/97	0	0	0
12/15/97	0	0	0
12/19/97	0	0	0
1/8/98	0.45	0.45	0.45
1/12/98	0	0	0
1/15/98	0	0	0.005
1/21/98	0	0	0.05
1/22/98	0	0	0
1/26/98	0	0.22	2.82
1/27/98	0	0	0.22
1/30/98	0	0.85	1.05
2/2/98	0	0	0
2/3/98	0	0	0
2/9/98	0	0	0

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
2/20/98	0.005	0.005	0.105
2/23/98	3.32	3.32	3.32
2/26/98	0	0	0.2
3/2/98	0.28	0.29	0.35
3/5/98	0	0	0.005
3/6/98	0	0	0
3/24/98	0	0	0.03
3/25/98	0	0	0
4/2/98	0	0	
4/3/98	0	0	0
4/6/98	0	0	0.11
4/8/98	0.25	0.25	0.25
4/15/98	0	0.005	0.005
4/28/98	0.005	0.405	0.805
4/29/98	0	0.005	0.45
5/18/98	0.03	0.03	0.03
5/29/98	0	0	0
6/3/98	0.12	0.25	2.88
6/24/98	0.67	0.67	0.67
7/7/98	0	0.02	0.39
7/16/98	0	0	0
7/20/98	0	0	0
8/3/98	0.005	0.005	0.01
8/11/98	0.13	0.13	0.13
8/17/98	0.05	0.05	0.05
9/15/98	0	0	0
9/29/98	0	0.01	0.01
10/7/98	0	0.005	0.305
10/14/98	0.27	0.27	0.28
10/15/98	0.005	0.27	0.27
10/28/98	0	0.5	0.5
11/10/98	0	0	0
11/12/98	0.37	0.37	0.37
11/13/98	0	0.37	0.37
12/9/98	0.4	0.4	0.4
12/10/98	0	0.4	0.4
12/18/98	0.05	0.05	0.05
1/12/99	0.005	0.005	0.155
1/13/99	0	0.005	0.005
2/9/99	0	0.5	0.5
2/10/99	0	0	0.5
2/24/99	0	0	0
2/25/99	0	0	0
3/9/99	0	0	0.57
3/10/99	0	0	0

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
3/18/99	0	0	0
3/23/99	0.04	0.04	0.04
3/31/99	0	0	0
4/12/99	0.91	0.91	2.11
4/13/99	0.005	0.915	0.915
4/14/99	0	0.005	0.915
4/26/99	0	0	0.5
4/28/99	0	0	0
5/10/99	0	0.25	0.25
5/11/99	0	0	0.25
5/12/99	0	0	0
6/7/99	0	0	0
6/8/99	0	0	0
6/9/99	0	0	0
6/11/99	0	0	0
7/12/99	0	0	0
7/13/99	0.42	0.42	0.42
7/14/99	0	0.42	0.42
8/9/99	0.35	0.35	0.35
8/10/99	0	0.35	0.35
8/16/99	0	0.35	2.6
8/18/99	0	0.005	0.005
9/7/99	0.005	0.065	0.065
9/8/99	0	0.005	0.065
9/20/99	0	0	0
10/4/99	0.005	0.005	0.005
10/20/99	0.005	0.01	1.02
10/25/99	0	0	0.2
11/17/99	ND	ND	ND
11/18/99	ND	ND	ND
12/8/99	ND	ND	ND
12/17/99	ND	ND	ND

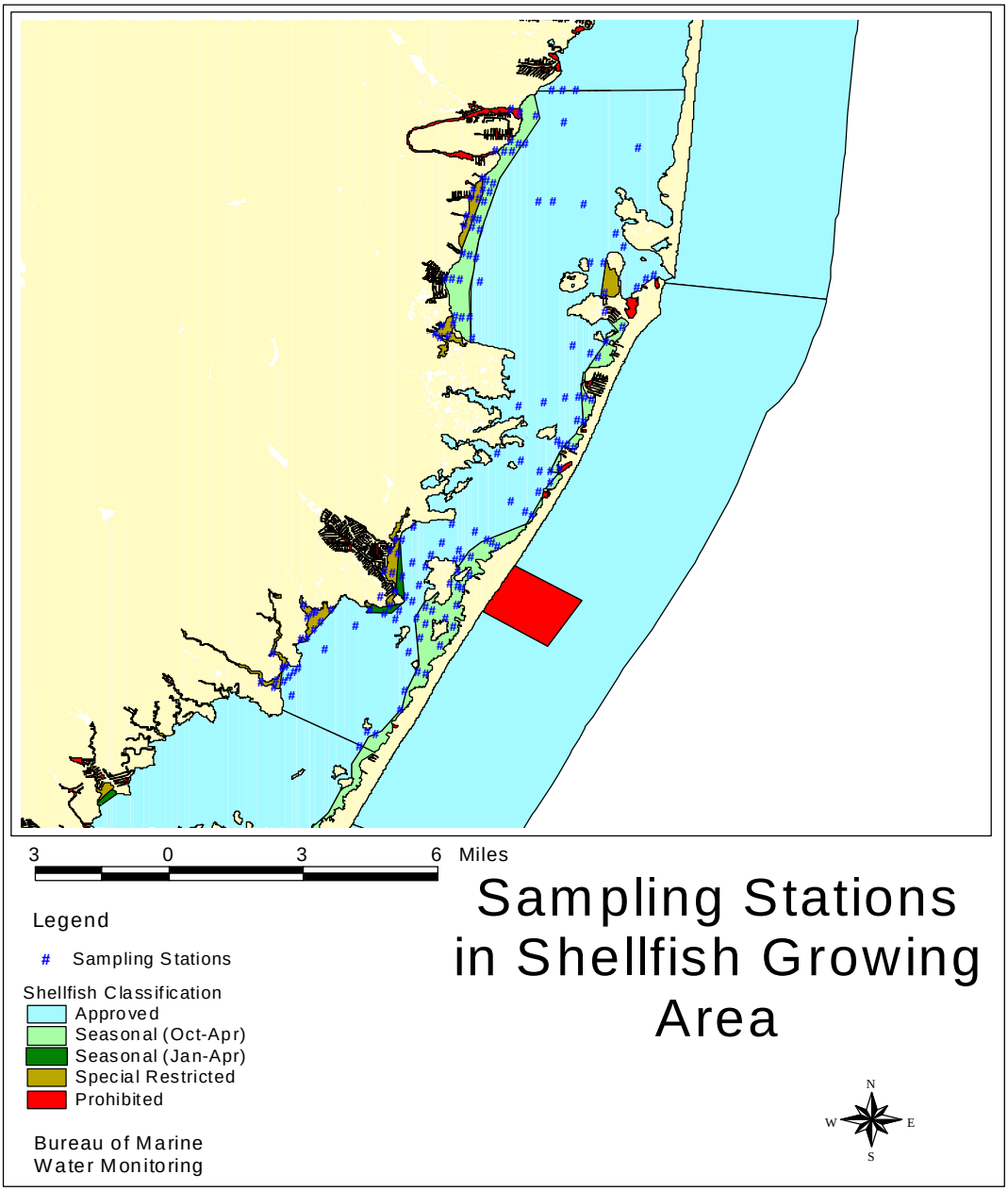
WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

The waters of this area are sampled under the Systematic Random Sampling Strategy. The Systematic Random Sampling Strategy is utilized in this shellfish growing area because there are no point sources that discharge wastewater that may contribute coliform laden contamination to the waters of the area.

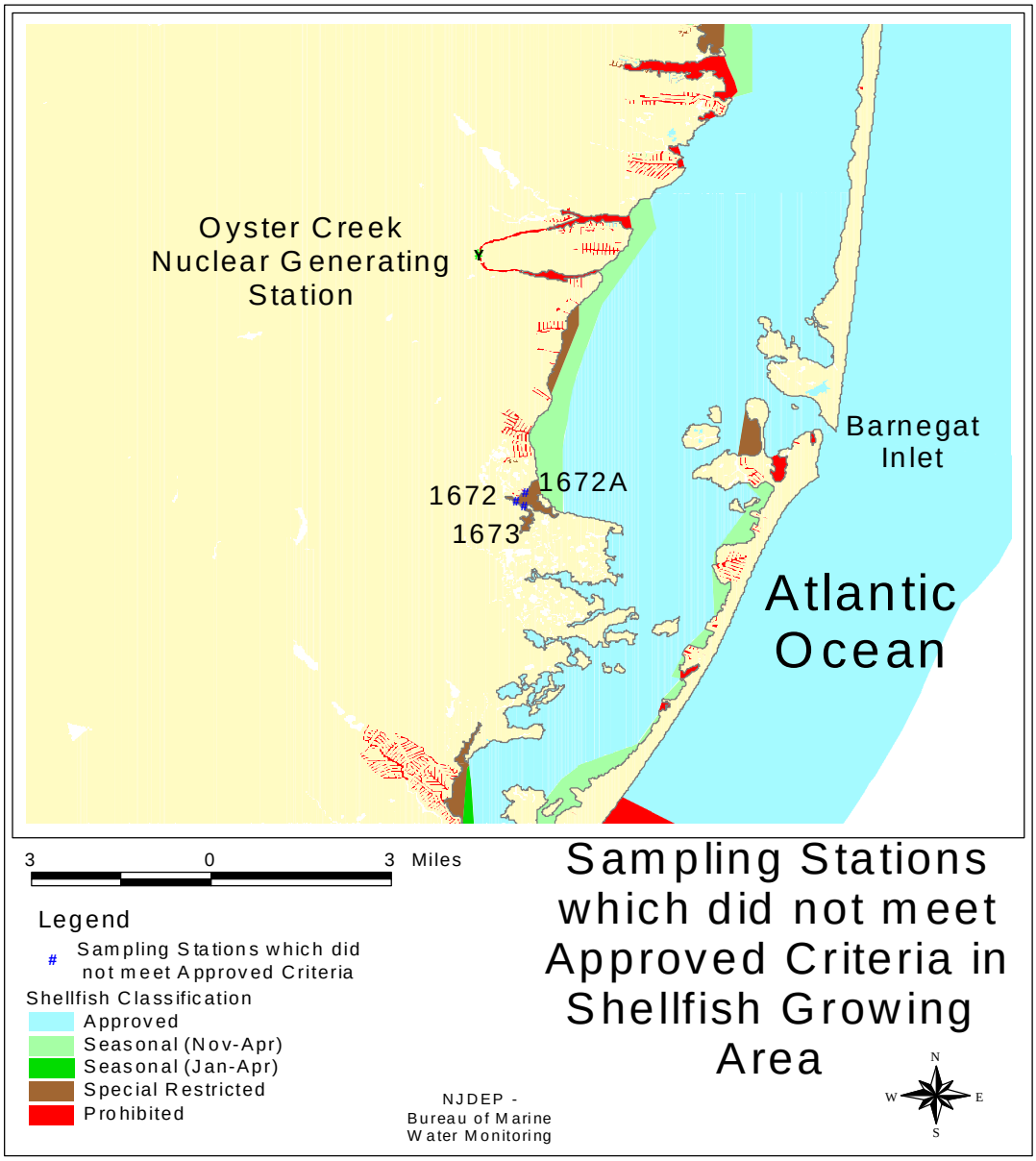
Samples of surface water were obtained from approximately 160 sampling stations. The water quality data collected for this area between January 1995 and September 1999 showed that the results of analysis for samples taken from all the sampling stations supported the current classifications for this area.

FIGURE 23: SAMPLING STATIONS IN SHELLFISH GROWING AREA



There were only three stations which did not meet criteria for *Approved* classification on the year round data, 1672, 1672A and 1673. These stations received year round results ranging from 30.4 MPN/100 mL to 35.5 MPN/100mL for geometric means, which would meet *Approved* criteria, but the estimated 90th percentiles for these stations ranged from 352.5 to 440.1, which exceed the *Approved* criteria of 330 for estimated 90thpercentiles. All of these stations are located close to each other in *Special Restricted* waters. All stations in this area meet criteria for *Special Restricted* waters.

FIGURE 24: SAMPLING STATIONS WHICH DID NOT MEET APPROVED CRITERIA IN SHELLFISH GROWING AREA



There were several stations which would exceed *Approved* criteria if only summer season data were evaluated. All of these stations are located in either *Prohibited*, *Special Restricted* or *Seasonally Approved* waters. All of these stations would meet *Approved* criteria if looking only at winter season data, and only three stations, 1672, 1672 and 1673, do not meet *Approved* criteria for year round data. These are stations which demonstrate the impacts of storm runoff and recreational boating experienced during the summer season when population in this area increases. The *Seasonally Approved* classified areas prevent the impacts during the summer from impacted harvested shellfish.

FIGURE 25: SAMPLING STATIONS WHICH DO NOT MEET APPROVED CRITERIA FOR THE SUMMER SEASON IN SHELLFISH GROWING AREA

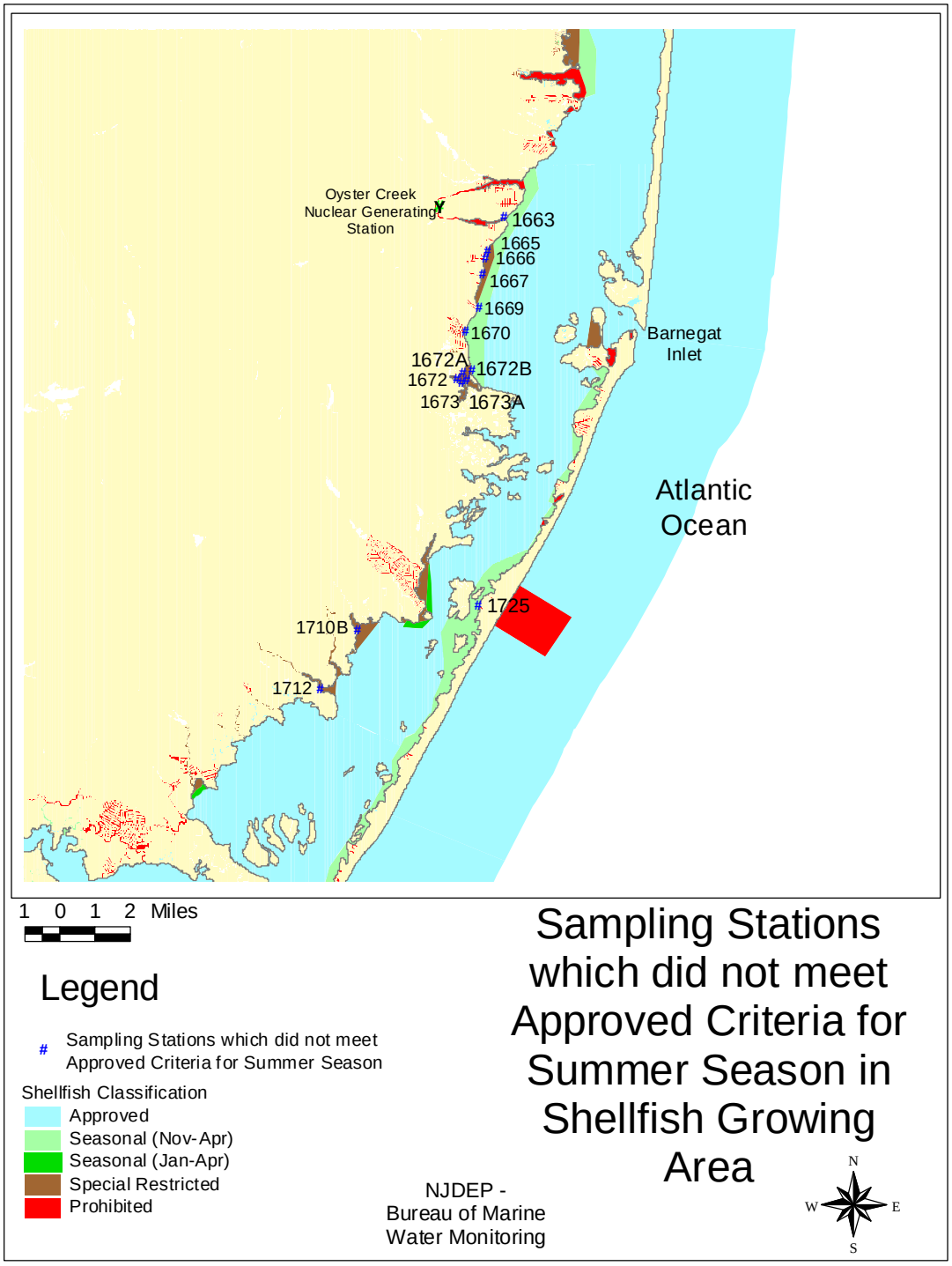


TABLE 4: STATISTICAL SUMMARY OF RESULTS FROM WATER QUALITY ANALYSIS OF SAMPLES COLLECTED FROM SHELLFISH GROWING AREA

Total Coliform Statistical

Report Area: *BB3*

From: *1/9/95* ***to*** *12/17/99*

Station	Depth	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
1654A	Surface	4.7	10.5	2			0	4.7	10.5	2
1654B	Surface	5.2	22.9	34	6.2	31.2	15	4.6	18.2	19
1654C	Surface	4.0	7.8	3	3.0		1	4.7	10.5	2
1661	Surface	5.7	32.5	48	7.8	87.4	21	4.4	10.8	27
1661A	Surface	5.8	34.0	48	8.0	75.2	21	4.6	15.6	27
1661B	Surface	5.6	22.1	48	9.0	54.1	21	3.9	7.3	27
1661C	Surface	3.7	6.6	21	3.8	7.9	11	3.5	5.4	10
1661E	Surface	3.1	3.5	21	3.1	3.4	11	3.2	3.5	10
1662	Surface	7.6	40.8	48	11.7	64.8	21	5.4	25.7	27
1662A	Surface	9.1	60.2	47	18.0	176.7	20	5.5	18.6	27
1662B	Surface	8.5	53.1	48	17.9	157.5	21	4.8	13.8	27
1663	Surface	18.9	197.7	47	57.2	745.2	21	7.8	29.8	26
1663A	Surface	11.8	88.4	48	28.9	219.9	21	5.9	26.5	27
1663B	Surface	7.3	40.1	48	14.9	130.4	21	4.2	8.1	27
1664	Surface	12.9	102.3	46	30.5	319.9	19	7.0	29.8	27
1664A	Surface	5.7	19.1	48	7.1	33.3	21	4.7	11.1	27
1664B	Surface	6.4	31.2	48	11.0	80.7	21	4.3	10.2	27
1665	Surface	16.1	193.2	48	46.8	620.1	21	7.0	43.7	27
1665A	Surface	7.4	40.1	47	15.4	101.4	20	4.3	13.3	27
1665B	Surface	5.2	21.0	48	6.9	42.6	21	4.2	10.0	27
1666	Surface	19.2	229.9	48	75.1	751.1	21	6.7	34.3	27
1666A	Surface	9.7	57.2	48	15.5	113.5	21	6.7	28.9	27

Station	Depth	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
1666B	Surface	7.0	33.8	48	7.4	42.9	21	6.7	28.4	27
1667	Surface	18.3	216.1	47	30.4	464.2	21	12.2	104.6	26
1667A	Surface	7.2	32.7	48	8.0	36.9	21	6.6	30.4	27
1667B	Surface	8.6	58.1	48	14.3	134.8	21	5.8	24.8	27
1668	Surface	13.4	135.1	48	16.1	190.9	21	11.7	105.6	27
1668A	Surface	9.8	80.9	48	13.4	141.4	21	7.7	50.6	27
1668B	Surface	7.0	39.6	48	7.6	53.9	21	6.7	31.5	27
1669	Surface	17.1	177.8	48	32.9	362.0	21	10.3	85.4	27
1669A	Surface	12.9	117.7	48	16.8	148.2	21	10.5	98.9	27
1669B	Surface	7.6	43.8	48	8.1	61.0	21	7.3	34.1	27
1670	Surface	20.6	303.8	48	53.8	1059.3	21	9.8	73.9	27
1670A	Surface	8.1	49.3	48	10.4	85.6	21	6.6	30.7	27
1670B	Surface	8.4	40.4	48	13.4	78.4	21	5.9	20.3	27
1670C	Surface	6.9	35.0	48	8.5	57.2	21	5.8	23.0	27
1671	Surface	6.4	33.7	47	7.6	53.9	21	5.5	22.4	26
1671A	Surface	8.2	53.4	48	13.1	130.7	21	5.7	21.5	27
1671B	Surface	6.5	32.8	48	7.4	52.1	21	5.8	22.2	27
1672	Surface	31.9	440.1	48	90.0	1942.5	21	14.2	72.8	27
1672A	Surface	30.4	352.5	48	73.3	1225.8	21	15.3	85.0	27
1672B	Surface	13.5	139.9	48	43.5	670.9	21	5.4	14.1	27
1672C	Surface	8.4	57.6	48	11.1	158.3	21	6.8	19.1	27
1673	Surface	35.5	425.2	48	78.4	966.1	21	19.2	172.1	27
1673A	Surface	23.8	255.5	48	63.8	949.0	21	11.0	50.2	27
1675A	Surface	7.5	25.7	32	13.4	58.4	10	5.8	15.1	22
1675B	Surface	7.2	30.8	31	7.0	37.2	9	7.2	29.5	22
1676A	Surface	6.1	21.6	32	7.0	26.0	10	5.7	20.3	22
1676B	Surface	6.0	23.1	32	8.0	60.3	10	5.2	13.2	22

Station	Depth	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
1677B	Surface	3.7	6.6	6	4.6	9.9	3	3.0	3.0	3
1678	Surface	4.2	12.2	6	5.9	26.7	3	3.0	3.0	3
1678A	Surface	5.0	14.0	39	6.8	21.4	13	4.2	10.7	26
1679A	Surface	4.8	13.2	39	5.2	13.4	13	4.7	13.3	26
1679D	Surface	3.0	3.0	5	3.0		1	3.0	3.0	4
1679E	Surface	4.0	9.0	32	3.8	8.6	10	4.1	9.3	22
1680A	Surface	4.0	6.8	6	3.2	3.6	3	4.9	9.7	3
1680B	Surface	3.8	7.8	39	5.0	14.6	13	3.3	4.7	26
1680C	Surface	3.6	5.7	6	3.0	3.0	3	4.3	7.8	3
1681	Surface	3.8	6.7	33	5.6	12.1	10	3.2	4.1	23
1681A	Surface	3.6	5.7	6	4.3	7.8	3	3.0	3.0	3
1681B	Surface	3.4	5.3	33	4.0	8.0	10	3.2	4.1	23
1681C	Surface	3.6	6.4	6	3.0	3.0	3	4.3	9.9	3
1682	Surface	3.2	3.6	6	3.4	3.9	3	3.0	3.0	3
1682A	Surface	4.5	10.7	39	5.7	16.8	13	4.0	8.1	26
1683	Surface	3.9	7.5	38	3.9	8.2	13	4.0	7.2	25
1683A	Surface	3.1	3.4	6	3.2	3.6	3	3.0	3.0	3
1683B	Surface	3.7	6.1	33	3.4	4.9	10	3.9	6.6	23
1683C	Surface	3.5	5.5	6	4.0	7.8	3	3.0	3.0	3
1684A	Surface	4.1	9.7	39	4.3	9.1	13	4.0	10.0	26
1684B	Surface	3.4	5.1	39	3.2	3.5	13	3.5	5.8	26
1684C	Surface	3.8	6.7	6	3.4	3.9	3	4.3	9.9	3
1685	Surface	4.5	9.6	33	5.5	14.2	10	4.1	7.9	23
1686	Surface	6.8	24.9	31	8.2	32.2	10	6.2	22.4	21
1686B	Surface	3.5	5.4	27	3.6	5.7	14	3.4	5.0	13
1686C	Surface	3.8	8.1	36	4.2	10.7	21	3.4	4.6	15
1686D	Surface	6.7	20.4	9	6.4	21.8	6	7.4	21.3	3

Station	Depth	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
1688A	Surface	3.7	7.2	35	4.0	8.8	21	3.3	4.9	14
1688B	Surface	4.2	8.2	35	4.4	8.2	21	3.9	8.1	14
1688C	Surface	4.1	8.2	35	3.9	6.9	21	4.3	10.4	14
1689A	Surface	4.2	9.7	36	4.3	10.5	21	4.1	9.0	15
1690	Surface	6.7	24.9	6	9.8	55.6	3	4.6	9.9	3
1690A	Surface	3.8	8.7	30	3.7	7.1	18	4.1	11.5	12
1691A	Surface	3.4	5.5	30	3.3	3.7	18	3.7	7.8	12
1691B	Surface	5.1	14.5	29	4.1	10.8	18	7.2	21.2	12
1691D	Surface	3.4	5.0	30	3.5	5.3	18	3.4	4.7	12
1691F	Surface	5.0	16.7	35	5.9	23.3	20	4.0	9.9	15
1700	Surface	4.6	15.7	37	5.6	24.9	19	3.8	8.6	18
1700A	Surface	3.1	3.4	6	3.0	3.0	3	3.2	3.6	3
1700B	Surface	5.5	21.9	33	10.5	66.4	10	4.1	11.0	23
1700C	Surface	5.7	28.9	39	12.7	136.0	13	3.9	7.6	26
1700D	Surface	4.9	20.1	39	9.8	87.6	13	3.5	4.9	26
1701	Surface	4.0	9.0	37	4.4	11.8	19	3.7	6.3	18
1701B	Surface	3.4	5.7	37	3.6	6.7	19	3.3	4.7	18
1701C	Surface	4.0	11.2	37	4.6	16.9	19	3.5	6.4	18
1702	Surface	7.5	43.3	31	21.3	306.5	7	5.6	18.5	24
1702A	Surface	6.6	33.8	59	11.4	89.3	21	4.9	16.4	38
1702D	Surface	4.2	11.8	37	4.8	19.0	19	3.6	5.6	18
1703	Surface	8.2	48.9	59	22.5	188.6	21	4.7	13.3	38
1703A	Surface	5.2	16.0	32	5.7	15.7	7	5.1	16.3	25
1703C	Surface	3.8	9.7	37	4.2	14.2	19	3.5	5.5	18
1703D	Surface	4.4	14.0	37	5.5	25.6	19	3.4	5.2	18
1704	Surface	8.9	46.3	58	21.8	142.3	21	5.3	15.6	37
1704A	Surface	5.8	18.1	58	8.6	30.5	21	4.6	12.1	37

Station	Depth	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
1704B	Surface	5.5	15.0	32	8.3	29.4	7	4.9	11.9	25
1704D	Surface	5.7	26.3	37	7.4	53.2	19	4.3	9.3	18
1705	Surface	6.3	22.5	33	15.5	87.3	7	4.9	12.7	26
1705A	Surface	5.6	19.8	38	7.6	34.9	19	4.1	9.1	19
1705B	Surface	4.8	13.1	33	4.5	12.7	7	4.9	13.5	26
1705C	Surface	4.0	10.4	35	6.0	28.6	8	3.6	6.9	27
1705D	Surface	3.7	9.5	35	7.4	44.0	8	3.0	3.2	27
1705E	Surface	3.9	8.3	35	6.1	20.4	8	3.4	5.4	27
1706	Surface	14.2	93.8	60	30.0	212.2	21	9.5	49.7	39
1707	Surface	9.0	48.1	60	17.9	137.6	21	6.2	21.3	39
1707A	Surface	5.6	21.8	33	6.9	39.5	7	5.3	18.8	26
1707C	Surface	5.6	28.6	61	8.6	65.7	21	4.5	16.6	40
1707D	Surface	4.2	12.2	35	9.6	63.8	8	3.3	4.3	27
1708	Surface	8.1	39.0	60	21.7	118.0	21	4.7	12.8	39
1708A	Surface	7.3	35.6	58	12.3	106.1	21	5.4	14.7	37
1708B	Surface	5.8	24.5	38	9.7	58.9	19	3.5	4.8	19
1709	Surface	16.3	101.1	32	68.0	277.9	7	10.9	54.0	25
1710	Surface	7.2	26.4	32	21.8	55.1	7	5.2	15.9	25
1710A	Surface	8.1	35.7	32	21.4	177.2	7	6.1	18.0	25
1710B	Surface	10.0	56.8	31	33.9	332.3	7	7.0	25.0	25
1711	Surface	8.1	38.3	59	15.6	85.1	21	5.7	20.1	38
1711B	Surface	7.2	35.5	59	13.5	84.5	21	5.1	18.0	38
1711C	Surface	5.7	21.0	32	9.0	46.7	7	5.0	16.3	25
1711D	Surface	7.2	34.6	59	16.0	95.3	21	4.6	14.0	38
1711E	Surface	7.6	39.1	59	22.9	151.4	21	4.1	8.5	38
1712	Surface	18.0	145.5	32	49.4	510.1	7	13.6	91.8	25
1713	Surface	7.3	23.4	32	8.3	25.9	7	7.1	23.1	25

Station	Depth	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
1713A	Surface	7.7	31.8	32	20.8	82.1	7	5.8	20.1	25
1713B	Surface	9.7	53.0	32	16.8	189.0	7	8.3	35.2	25
1714	Surface	10.8	62.5	32	16.9	117.4	7	9.5	52.6	25
1714A	Surface	14.0	106.2	57	46.1	267.9	19	7.7	42.5	38
1715	Surface	5.8	20.6	32	10.1	65.4	7	5.0	13.6	25
1715A	Surface	5.2	15.7	36	6.4	25.2	19	4.0	7.7	17
1715B	Surface	6.1	20.8	32	8.8	38.3	7	5.5	17.3	25
1715C	Surface	7.8	33.8	37	10.2	58.0	19	5.8	16.6	18
1716A	Surface	3.9	7.5	34	3.8	7.0	7	4.0	7.8	27
1717A	Surface	4.5	12.6	62	6.2	23.2	22	3.8	8.0	40
1717B	Surface	5.7	27.6	38	8.7	61.9	19	3.8	8.4	19
1717F	Surface	6.8	31.3	37	8.3	44.1	19	5.4	21.3	18
1718	Surface	5.2	18.3	62	10.2	57.1	22	3.6	5.8	40
1719	Surface	4.0	9.3	62	5.7	16.7	22	3.3	5.7	40
1719F	Surface	6.4	32.0	37	10.0	73.5	19	4.1	8.3	18
1720	Surface	5.2	20.3	39	11.6	110.6	9	4.0	8.9	30
1720A	Surface	4.5	12.7	26	7.7	50.4	5	3.9	8.0	21
1721A	Surface	4.4	12.4	38	6.2	23.4	19	3.2	3.6	19
1721D	Surface	6.3	26.3	59	10.2	57.5	21	4.8	14.7	38
1722	Surface	5.1	18.2	35	12.2	97.1	8	4.0	7.8	27
1722C	Surface	4.3	13.5	35	11.9	80.3	8	3.2	4.0	27
1723	Surface	4.8	15.1	35	11.9	72.1	8	3.6	6.4	27
1724	Surface	5.0	14.7	34	15.2	59.1	7	3.7	6.9	27
1725	Surface	13.0	127.4	39	43.7	716.1	13	7.0	32.1	26
1725A	Surface	5.1	19.8	33	11.1	87.1	10	3.7	6.3	23
1725B	Surface	5.4	21.1	39	8.3	56.3	13	4.4	10.8	26
1726	Surface	5.1	14.5	33	8.8	30.6	10	4.1	9.0	23

Station	Depth	Year Round			Summer			Winter		
		Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N	Geometric Mean	Est. 90th	N
1726A	Surface	4.7	10.6	33	7.7	17.0	10	3.8	7.4	23
1727	Surface	6.2	23.4	39	17.2	78.1	13	3.7	6.1	26
1727A	Surface	5.4	22.3	5	11.8	102.4	2	3.2	3.6	3
1727B	Surface	5.2	16.7	39	10.1	46.9	13	3.8	6.8	26

RELATED STUDIES

Two related studies are conducted in this area. First, four (4) nutrient samples are collected each year in this area. The results of the nutrient sampling are compiled into a separate report by the Bureau of Marine Water Monitoring. Second, data is collected as part of the phytoplankton monitoring program for which the Department collects samples at regular intervals throughout the summer to determine the occurrence of marine biotoxins. This data is evaluated weekly by the Bureau of Marine Water Monitoring in accordance with the NSSP requirements.

There was a large phytoplankton study performed in this area during the summer of 1999, due to the occurrence of a "brown tide" in the waters of this area. Brown tides are blooms of specific types of algae which cause a brown coloration in the water. Brown tides can result in impacts which include reduction of shellfish growth, reduction of habitat and reduction of finfish populations. Brown tides have not been identified as being hazardous to human health. A report relating to this occurrence was completed separately by the Bureau of Science and Research. The Bureau of Marine Water Monitoring completed a related report studying the presence of chlorophyll, which is used as a measure for presence of phytoplankton, for this area during the same time period.

The report relating to the presence of chlorophyll found that there was a pattern of elevated chlorophyll a levels in the area of Cedar Bonnet Island, where Route 72 crosses Barnegat Bay from the Mainland to Long Beach Island. There is an on going investigation being conducted in an effort to find possible reasons for the elevated chlorophyll levels.

Connected to this study, data sondes, automatic water sampling and testing equipment, were placed in the waters in and around where the brown tides were occurring during 1999. The data sondes were left to gather data for week long periods. This was done for three weeks during the summer of 1999. The data sondes test and record a number of parameters including, pH, salinity, dissolved oxygen, temperature and turbidity. The data collected is available on the Bureau's website at www.state.nj.us/dep/watershedmgt/bmw/index.htm.

INTERPRETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

Criteria for acceptability of shellfish growing water based on bacterial parameters are provided in the *Guide for the Control of Molluscan Shellfish, Part IV, Shellfish Growing Areas* (USPHS, 1997, revision). Each state must adopt either the total coliform criteria or the fecal coliform criteria for growing water classifications. Historically, the New Jersey Department of Environmental Protection has based growing water classification on the total coliform criteria and continues to use total coliform criteria.

The total coliform standard does not need to be applied if it can be shown by detailed study of laboratory findings that the coliform are not of direct fecal origin and do not indicate a public health hazard. The New Jersey Department of Environmental Protection takes corresponding samples for fecal coliform analysis with each sample taken for total coliform analysis, however this data is utilized as adjunct information and is not used for classification of shellfish growing waters. Data analysis is based on the total coliform results. The total coliform geometric mean MPN for *Approved* classification must no exceed 70 counts/100 mL and not more than 10% of the samples can exceed an MPN of 330 counts /100 mL, where the three tube decimal dilution test is used. Areas classified as *Special Restricted* must meet the criteria of 700 counts/100 mL and have fewer than 10% exceed a MPN of 3300 counts/100 mL.

Approximately 5735 water samples from 160 sampling stations were analyzed by the laboratory of the Bureau of Marine Water Monitoring at Leeds Point for total coliform (TC) and fecal coliform (FC) bacteria during the period of time from January 1995 to September 1999. The water quality data was evaluated using criteria applicable to the Systematic Random Sampling Strategy. The results of the data collected from sampling in this shellfish growing area indicate that all waters classified as *Approved* met the criteria for classification as *Approved* waters.

There were only three stations which did not meet criteria for *Approved* classification on the year round data were 1672, 1672A and 1673. These stations received year round results ranging from 30.4 MPN/100 mL to 35.5 MPN/100mL for geometric means, which would meet Approved criteria, but the estimated 90^{th} percentiles for these stations ranged from 352.5 to 440.1, which exceed the Approved criteria of 330 for estimated 90^{th}percentiles. These stations are located close to each other in *Special Restricted* waters and meet criteria for *Special Restricted* waters.

There were several stations which would exceed *Approved* criteria if only summer season data were evaluated. All of these stations are located in either *Prohibited*, *Special Restricted* or *Seasonally Approved* waters. All of these stations would meet *Approved* criteria if looking only at winter season data, and only three stations, 1672, 1672A and 1673, do not meet *Approved* criteria for year round data. The stations with these data

are all located close to area of urban, most in close proximity to lagoon communities. These are stations which demonstrate the impacts of storm runoff and recreational boating experienced during the summer season when population in this area increases.

Many of the urban developed lands in this area experience significant seasonal fluctuation in population. During the summer months increased population due to tourism results in increased impacts to the waters of this area due to storm water run off carrying greater amounts of domestic pet fecal waste, petroleum waste and other waste residual, as well as increased impacts due to large amounts of recreational boats being operated during this time period. This is why most of the urban developed lands in this area have sections of *Seasonally Approved* waters located near them. The *Seasonally Approved* waters prevent shellfish harvesting during the summer months when impact would be the greatest.

There were a few dates when there were numerous sampling stations with elevated coliform levels. These dates include elevated coliform levels in stations which are in proximity to the bay shore in the northwest of this area, from the area of Forked River to the area of Barnegat Township. This is an area with significant amounts of urban development. Most of the dates when numerous stations received high coliform counts were dates when substantial rainfall was experienced prior to the sampling date. This demonstrates the impacts of storm water runoff from urban areas on the waters of this area.

The one exception was the results for the sampling date of January 13, 1997. On this date there was not any substantial precipitation preceding the collection of the samples. The elevated coliform results of this date centered around a few stations near l669 and tapering off quickly along the shoreline, with non detected levels at station 1663 and 23.0 MPN/100 mL for total coliform and 3.6 MPN/100 mL for fecal coliform at station 1673A, the furthest south station in the sampling run for that date. No reason for the elevated results on this date were able to be identified. However, due solely to the proximity of the stations with elevated results to the shoreline of this urban developed area, the cause may be associated with an unidentified land based source.

TABLE 5: RANGES OF RESULTS FROM DATES WITH NUMEROUS SAMPLING STATIONS WHICH RECEIVED ELEVATED COLIFORM LEVELS

Sampling Date	Total Coliform Count Ranges (MPN/100 mL)		Fecal Coliform Count Ranges (MPN/100 mL)		Precipitation (inches)		
	Min	Max	Min	Max	24 hrs Prior	48 hrs Prior	72 hrs Prior
7/11/95	N/D	240.0	N/D	150.0	0.8	0.8	0.8
6/18/96	240.0	2400.0	210.0	1100.0	1.42	1.42	1.42
8/14/96	9.1	240.0	23.0	43.0	1.5	2.9	2.9
12/2/96	3.6	2400.0	23.0	2400.0	1.65	1.7	1.7
1/13/97	N/D	460.0	N/D	460.0	0	0	0.2
10/15/98	9.1	460.0	3.0	43.0	0.005	0.275	0.28

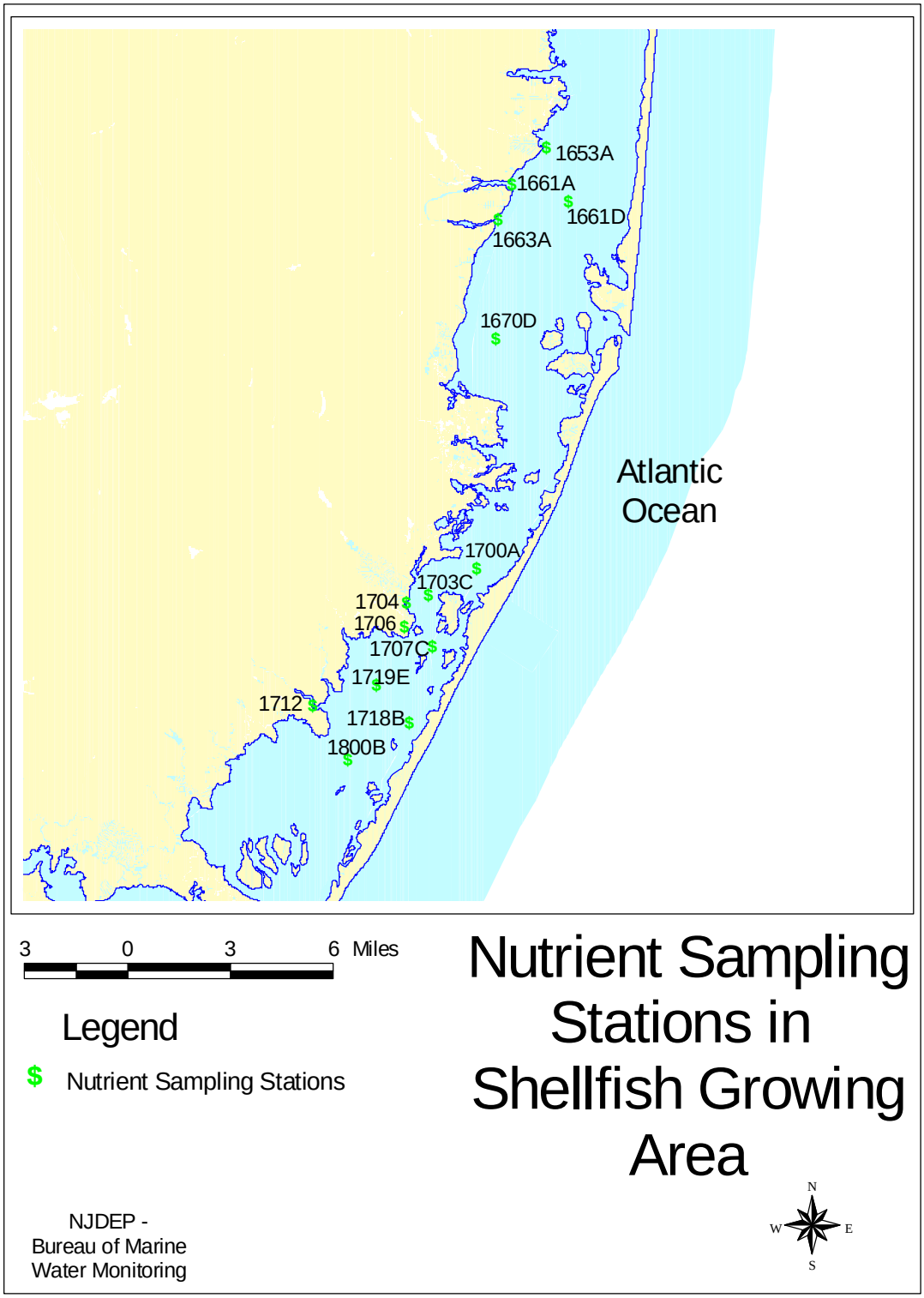
All the sampling stations in the *Seasonally Approved* classified waters around this area met *Approved* criteria for year round data for the period covered by this report. It was only in looking at summer season only data that some of stations in this region in the northwest bay shore of this shellfish growing area that a few of the station would not have met *Approved* criteria, but not enough samples area available for summer only data for this area for the period covered by this report to make that assessment statistically significant. It does demonstrate that the section of *Seasonally Approved* classified waters surround this region of the shellfish growing area is effective in preventing harvesting of impacted shellfish, since it prevents harvest during the summer season, when impacts would be the greatest. The following table documents some of the dates when the most elevated coliform were experienced, along with precipitation amounts preceding those dates.

There are also numerous dates when there were isolated sampling stations with slightly elevated coliform results, generally less than 150 MPN Counts/100 mL. These results are functions of inherent biological variation.

NUTRIENTS

There are 24 sampling stations utilized in sampling for various nutrients. The most recent results of the sampling for nutrients and dissolved oxygen is compiled in a separate report. The most recent edition of the Ambient Monitoring Program – Report on Marine and Coastal Water Quality was compiled in 1999 by the NJDEP covering data from 1997 through 1999. It is available on the NJDEP – Bureau of Marine Water Monitoring's website at www.state.nj.us/dep/watershedmgt/bmw/index.htm.

FIGURE 26: NUTRIENT SAMPLING STATIONS IN SHELLFISH GROWING AREA



TOXICS

There has been a system for monitoring for toxics from phytoplankton present statewide in New Jersey since 1977. Sampling stations are selected for each run to be utilized to sample waters to gauge which species are present and the amount of chlorophyll in the sample as a meter of productivity. There have been no incidents of algal blooms of species of phytoplankton associated with acute toxics in New Jersey jurisdictional waters. There have been numerous occurrences of "red tides", "brown tides" and "green tides". None of these occurrences involved species associated with acute toxic agents. There have only been a few minor illness for bathers from blooms associated with *Prorocentrum sp*. and *G. aurealum*, but not during the time period covered by this report and not in the area covered by this report. A yearly report of the results of the phytoplanton sampling is compiled by the NJDEP Bureau of Marine Water Monitoring.

This area has experienced recurring "brown tides" since 1995. These brown tides have been associated with blooms of *Nannochloris atomus* and *Aureococus amphagefferens*. The brown tides experienced in this area have had no toxic effects noted in connection to them. The primary deleterious effects of the brown tides in this area are loss of aesthetic quality of the water and occasional fish kills due to anoxia from the decay of the phytoplankton.

The National Oceanic and Atmospheric Administration maintains several mussel watch stations in New Jersey. The mussel watch stations sample mussel tissue to monitor a number of parameters. Some of the primary parameters tested in the mussel tissue is the presence of heavy metals. There is a mussel watch station near the area of Barnegat Inlet. There have been no levels of heavy metals present in mussels tested at this station which have been of concern.

CONCLUSIONS

BACTERIOLOGICAL EVALUATION

Based on water quality data obtained from sampling between January 1995 and September 1999, all areas classified as *Approved* waters in this area continued to meet NSSP criteria for the *Approved* classification.

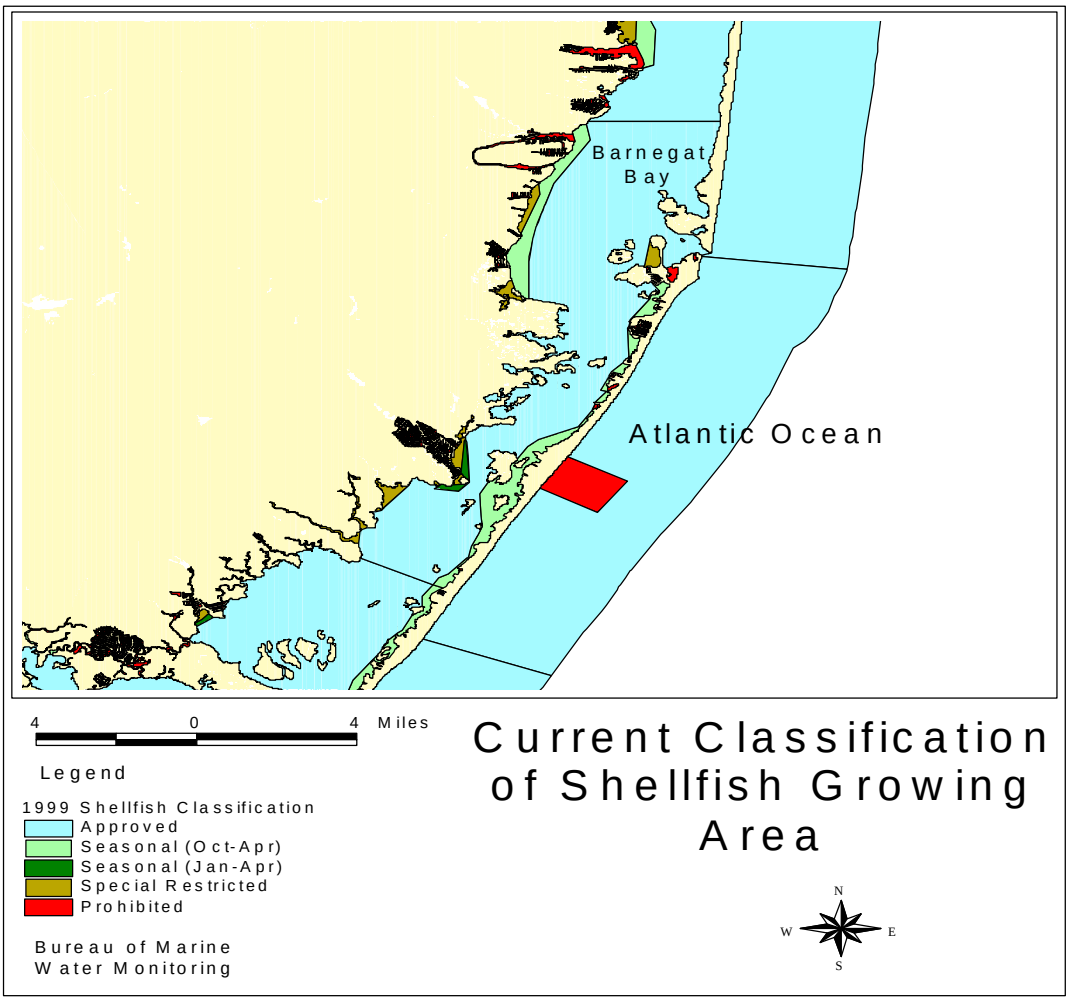
There were no indications that any impacts to the *Approved* waters of this area originated from Oyster Creek Nuclear Generating Station. As well, there are no indications that any indirect sources of contamination have caused any impacts to the *Approved* waters of this area. All results for sampling stations located in *Approved* waters met established criteria for *Approved* water. Only two sampling stations in the area

failed to meet criteria for *Approved* water, and these stations were located in *Special Restricted* waters, for which they met criteria.

A few of the sampling stations would not have met *Approved* criteria if only summer season data alone were considered. However, all these stations are located in *Prohibited, Special Restricted* or *Seasonally Approved* waters. This demonstrates that the buffer zones established with the area of *Prohibited, Special Restricted* and *Seasonally Approved* waters work to prevent impacts to *Approved* waters in this area.

The only area of concern for this area is the recurring algal blooms which occur during the summer months in this area. Monitoring of these "brown tides" has demonstrated no threats to human health. No actions are recommended relating to the brown tides at this time due the fact that it has been identified that the brown tides pose no threat to human health or well being. However, continued study of these phenomenon for the purpose of preventing any possible occurrences of toxic blooms and identifying the cause of the blooms is recommended.

FIGURE 27: CURRENT CLASSIFICATION FOR SHELLFISH GROWING AREA

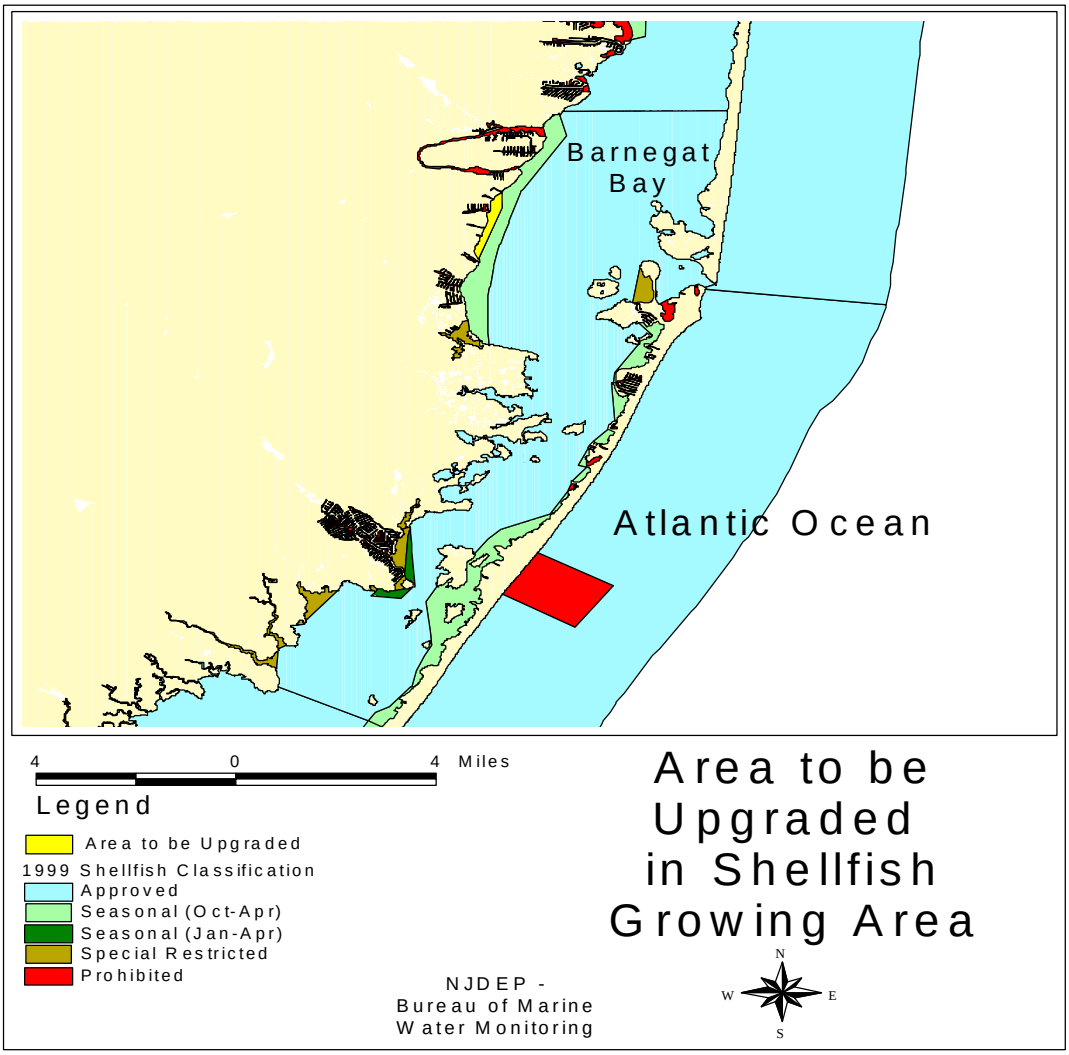


RECOMMENDATIONS

BACTERIOLOGICAL EVALUATION

There is one change in classification recommended for this area. The section of *Special Restricted* classified water along the northeast shoreline in this area is recommend to be upgraded to *Seasonally Approved* classification, to match the classification of the waters around it. The results of sampling for stations 1665, 1666 and 1667, which are inside the section to be upgraded, indicate that the stations meet criteria for *Approved* classification for year round data, but have elevated coliform levels for summer season data. This is consistent with waters classified as *Seasonally Approved*. An area of 191 acres of shellfish growing waters will be upgraded from *Special Restricted* classification to *Seasonally Approved* classification.

FIGURE 28: AREA TO BE UPGRADED IN SHELLFISH GROWING AREA



Legal Description for Recommended Changes:

The following changes to the legal description for this area, New Jersey Administrative Code 7:12-3.2(a)12 – Western Barnegat Bay – Forked River to Conklin Island, and , New Jersey Administrative Code 7:12-4.1(a)2iii – Barnegat Bay – Forked River to Barnegat, need to be made. This description includes the entire 191 acres to be upgraded.

New Jersey Administrative Code 7:12-3.2(a)12

iii. [All waters south and west of a line beginning on the northern bulkhead at the mouth of an unnamed lagoon (lying between Beacon Drive and Nautilus Road in Ocean Township) and bearing approximately 180 degrees T to Department maintained marker "AA" (located approximately 400 yards east of Flashing Red light "2" (F1 R "2") at the mouth of Waretown Creek) and then bearing approximately 195 degrees to the Department maintained marker "BB" (located approximately 400 yards east of the mouth of South Harbor) and then bearing approximately 200 degrees T, through Department maintained marker "CC", to Flashing Red light "2" (F1 R "2") marking the entrance to the Barnegat Beach lagoon system where it terminates; and

iv.]

shall be removed from the regulations, and

New Jersey Administrative Code 7:12-4.1(a)2iii

(1) All those waters [east of the Special Restricted waters described in N.J.A.C. 7:12-3 and] west of a line beginning at the easternmost point of land immediately north of Forked River (Department maintained marker) approximate location: latitude 39 degrees 49 minutes 53 secons N., longitude 74 degrees 9minutes 17 seconds W.) and bearing approximately 167 degrees T to Flashing Red light "2" (F1 R "2") located off the mouth of Forked River, and then bearing approximately 212 degrees T to Flashing light "3" (F1 "3") marking the entrance to the channel to Oyster Creek, and then bearing approximately 204 degrees T through Department maintained markers "A" and "B" to Department maintained marker "C" located approximately 0.4 nautical miles east of Flashing Red light "2" (F1 R "2") marking the entrance to Waretown Creek, then bearing approximately 194 degrees T through Department maintained markers "D" and "E" to Department maintained marker "F" located approximately 0.5 nautical miles east of Flashing Green light "I" (F1 G "1") marking the entrance to Lochiel Creek and the Pebble Beach lagoon complex, and then bearing approximately 180 degree T through Department maintained marker "g" and terminating at the range marker (Department maintained) located on Conklin Island.

Recommended Changes in Monitoring Schedule

There are no changes in sampling stations recommended for this area. There were increases in the amounts of samples planned for two sampling assignments, 102 and 108, in 2000. These increases were planned before the writing of this report. No further changes for sampling assignments are recommended

Other Changes Recommended

Due to the large amounts of urban development present in proximity to marine waters in this area, there is significant potential for contaminants which would not be indicated by coliform testing impacting the marine waters. It is likely that toxics, such as heavy metals and polyaromatic hydrocarbons (PAH), impact the marine waters and shellfish of this areas. These materials may originate from preserved wood in marinas and dock, storm runoff laden with petroleum material from road ways and material from known contaminated sites, which may runoff with storm water or leach through soils to mix with marine waters directly or with freshwater sources and then run down stream to marine waters.

A study to analyze sediments and shellfish tissues should be performed to monitor levels of toxic materials such as heavy metals and PAH's. Though there are few standards set for these contaminants by the United States Food and Drug Administration, monitoring of heavy metals and PAH's would help to ensure public health by identifying potential problem locations where these contaminants may be accumulating in shellfish. This monitoring program would also help to provide an indicator for the general quality of the environment in New Jersey.

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APPENDICES

APPENDIX I

Results of Analysis of Samples Taken for Analysis

In Shellfish Growing Area –

Little Egg Harbor to Barnegat Bay